The Application of Compressed Air to Mining.*

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Amongst the many subjects which the Mining Engineer has to study, that of the transmission of power occupies a very prominent position.

In these days of trade unionism, which by the bye, means hostility to the employer; when restriction of labor is the order of the day, especially so amongst colliers, and when they—the colliers—want a week's wages for about four days' work, it is most desirable that manual labor should be substituted as far as possible by mechanical appliances. The writer would be one of the last to refuse to give the collier his due; he is exposed to many dangers, seen and unseen, but on the whole his avocation will bear favorable comparison with many other branches of industry which might be cited.

Although the mechanical engineer has been called in to effect the desired object, really very little has yet been done in the shape of automatic work; whether this fault is due to the engineer or the collier, or both, is hard to say, but there can be no doubt but that the collier is very reluctant to accept any innvoation, and he is a very difficult subject to convince that anything could possibly be introduced for his benefit. It is true that rope haulage has to a large extent substituted "putting," "wagoning" and pony work, that rock percussion drills have superseded the old method of boring by hand, and that coal cutting machines have been introduced to relieve the collier of some of his hardest work, *i. e.*, that of holing or undercutting beneath, or in the coal; but although a great deal of ingenuity has been displayed in many of the last named class of machines, and a certain measure of success claimed by each inventor for their respective machines, yet none seems to have come into popular use. The immediate object however, of this paper is to treat of the various methods employed for the transmission of power, especially that of compressed air, rather than of the machinery to which the power is to be directly applied.

The methods usually employed are:—

I.—Steam.
II.—Water.
III.—Wire ropes.
IV.—Compressed Air, and, lastly, Electricity.

1. *Steam.*—It must be admitted by all that steam has, and is doing good service underground, but it is extremely limited in its powers of application; where circumstances are favorable it is undoubtedly the cheapest and most efficient known power for underground work. If, for instance, you have a dry shallow shaft, say from 80 to 90 yards deep, the coal giving off little or no explosive gas, where you can carry your steam pipes down the upcast shaft, and you wish to apply your power near the bottom of the upcast, so that the exhaust steam may be carried back through the same shaft, or be condensed near the engine, this may be considered a fairly favorable circumstance. But even here you would be subject at any time to the blowing of a joint in the steam pipes, and if the exhaust was thrown into the shaft it would be rather warm work for a workman to go to repair the said joint.

Again, in a non-fiery mine, you could conveniently fix your engines near the upcast to do the work required, and if you should be sufficiently fortunate in getting good strong and dry ground in which you could cut out a boiler-room, without having a long smoke drift, this would be considered a favorable condition and where you would be justified in using steam power The heat from the boiler furnace would augment the ventilation, also the exhaust steam turned into the smoke drift would still further help to increase the same. Under these latter circumstances, the writer employed steam at the deep pit of the Kingswood Collieries, near Bristol, with satisfactory results. At the Speedwell pit of the same collieries, the circumstances were entirely different, and means for providing power had to be devised.

The pit was a down-cast, 510 yards deep, and barely 9 feet in diameter. From the bottom of this shaft a tunnel was driven out 311 yards, undercutting the coal, and at the point this reached, the power sought had to be applied. All the coal had been won to the rise side of this point, and all the coal to be gotten lay to the deep, to win which it was found necessary to put up some good "hauling machinery," and powerful as well, as the seams dipped 1 in 3. The upcast shaft was away to the rise at a distance of rather more than 600 yards.

It was especially necessary that at this point powerful machinery should be laid down, (1) Almost the whole of the coal to be won lay to the dip: (2) The distance to the boundary was rather over 1¼ miles; (3) The gradient was 1 in 3.

Now when you come to consider that the shaft was 500 yards deep, and then the seam dipping 1 in 3 for 1¼ miles, or 2,640 yards, it is a simple matter of calculation to ascertain at what depth the seam would be below the surface at the extreme dip, assuming the surface to be level. A shaft to reach the coal at the extreme point referred to would have to be sunk a depth of 1,380 yards —a depth we have not yet attained by any shaft in coal mining. Our deepest coal shaft in England is that at Ashton Moss, near Manchester, which, if I remember rightly, is about 936 yards deep. You will readily see, therefore, that the only course open to us was to drive down on the dip of the seam. Those who are unaccustomed to deep shafts have a difficulty in realizing what a deep shaft means, and a shaft of, say, 1,300 yards is better understood if you look at an ordinary colliery chimney, say 130 feet high and then try to conceive 30 such chimneys piled one above the other. Taking all these things into consideration, it was determined that the hauling engines should be fixed at the point referred to. The next question was the power to be employed. It should be mentioned, also, that there was another important matter to be considered, which was, that at 700 feet from the surface, in the downcast shaft, the bulk of the water which the colliery yielded was given off, and it was desirable that this water should be pumped to the surface from this point. Already a recess had been cut out in the shaft side, and a large Tangye pump set to work by steam power. As we had no communication with the upcast, the chief difficulty was to get rid of the exhaust steam. We tried one of Holman's Condensers, but on account of the height to which the water had to be lifted, and the consequent disparity in the relative sizes of steam cylinder and water, it did not work effectively. We then improved one which worked very well, but as our pumping rams were fitted with "cupped leathers," these latter would not last more than a couple of days, the water being too hot. After having been used for condensing, frequent tests were made of the temperature of the water as it was delivered at surface, and, although travelling up for 700 feet, the thermometer recorded 109° Fahr.

The pit was a wet one also. Although the steam pipes were covered with a non-conducting material, and then an outer casing of sheet iron, we lost uniformly 15 lbs. pressure between the surface and the pumps through condensation. Altogether it was very unsatisfactory. Apart from the pumping, steam was first thought of for the underground haulage. We therefore looked into the different and varied ways by which steam could possibly be applied, as follows:

1. To fix our hauling engines on the surface, and convey ropes down the shaft, pass it around pulleys at the bottom, and then along the tunnel to the top of the incline brow; our objection to this method was based on a two years' experience at the Deep Pit, where we had worked it for hauling from an incline 700 yards, dipping 1 in 3. The shaft was 500 yards deep, then a tunnel of 100 yards, so that the length of rope to begin with was 1,350 yards, or 600 yards of dead rope. Frequently the empty wagons would get off the rails, and, before the engineman could be signalled to stop, a dangerous accumulation of slack rope would be dangling about in the shaft; the weight of rope hanging vertically in the shaft kept the rope tightly on the drum, so that the engineman would not detect the mishap in time. To obviate the rope getting out into the shaft it was enclosed in wooden piping, but this did not mend matters, for when the rope broke, as it did sometimes, one end would be frequently at an inconvenient distance from the bottom up this piping, and involved great delay in getting down again for splicing, frequently stopping the coal winding for an hour or two. At other times a few wires would break and stick out, and rip up the piping. Iron piping would have obviated this latter grievance to some extent, but to this also there were objections. There was yet another objection: with such a length of dead rope it was necessary to get as light as possible, and we used the very highest class of steel rope procurable (best plough steel); the drippings of the pit, however, kept that part of the rope hanging in the shaft constantly wet, and this portion had to sustain the highest tension. We found, however, that the corrosion was very rapid, and, unfortunately, that the higher the class of steel the more rapid the oxidation ensued. So this idea was abandoned.

2. To convey steam in pipes along the tunnel to the engine at the top of the incline. Our experience with steam pipes in the shaft for the pumps was sufficient to decide against this plan.

3. To drive a tunnel from bottom of downcast up to the bottom of upcast, fix boilers and engine at that point, and lead the hauling rope along the tunnel on rollers.

4. To carry out the last idea, with the exception of fixing the engines there, and instead of leading the rope along the tunnel, to carry the steam in pipes to the top of the incline, and there fix the engines.

3 or 4 would be preferable to either 1 or 2, but either would be very costly and ineffectual.

There was another method, *i. e.*, to drive upon the seam to the bottom of the upcast shaft, make a smoke drift, and fix the boilers and engines near the incline top. This looked more feasible than either of the other methods, and induced us to go carefully into the cost. It worked out something like the following:

	£	s.	d.
600 yards to drive rise heading on the two feet seam, ripping, loss, etc., at 20s.	600	0	0

The coal gotten would probably pay for the haulage neither have I reckoned for reels and rails, windlasses.

Arching when finished should be 4 ft. 6 in., by 4 ft. 6 in., that is, 4 ft. 6 in. wide, and 4 ft. 6 in. from floor to crown, this would take:

250,000 common bricks, at 22s.	575	0	0
20,000 fire bricks, at 55s	55	0	0
Mortar, about 2s. 6. per yard	75	0	0
Getting materials up drift, and packing	600	0	0
Getting materials into works	30	0	0
Making room for two boilers, 630 cubic yards at 3s. 4d.	105	0	0
Three walls, allowing for breakages,—41,000 bricks at 22s	45	2	0
Mortar	8	0	0
Masons building about 90 perches, at 2s. 6	11	0	0
Timber baulks	20	0	0
Materials conveyed to works	5	0	0
Extra cost getting boilers underground, as compared with setting on surface	50	0	0
Incidentals	20	13	0
Total	£1900	0	0

To this amount I must add the cost of ventilating the drift whilst it was being driven, and all this sum would have to be spent extra and above what it would cost for fixing the boilers on the surface; and, again, 600 yards of smoke drift driven through the seam, although encased with three or four widths of brickwork, and packed dry with well burnt ashes, is not without its dangers. The drying up of a wet muddy joint in the strata, at the crossing of one of the many faults we should meet with, would possibly cause a collapse in the flues, perhaps at some remote point of access which would suddenly bring all your machinery to a standstill, and might cause the loss of a week's work or more, in laying off for repairs. These and numerous other contingencies incident to steam in the colliery, caused us to turn our attention seriously to some other power, and the power we fixed on was compressed air. Before, however, deciding definitely in the matter, we resolved to gather all the information procurable, and see what others who were using this power were doing and to ascertain their opinions.

The North of England and South Wales were visited; amongst the former Ryhope and Shireoak. At the latter, Powell's Duffryn (Sir George Elliott's), South Wales Colliery Co., and New Tredegar.

At Powell's Duffryn they had dispensed with forty horses by the application of compressed air. At New Tredegar, all their workings were 1,580 yards below their pit bottom levels, and by this method they are hauling 800 tons per day.

Mr Taylor, of Ryhope Colliery, enumerated some of its advantages, as follows:

1. It is obviously of great importance to have a large power which can be applied to any purpose and at any moment to any part of the mine.

2. Possessing this power, it is a mere question of detail to use means for working the coal and bringing it to the point from which it is to be led by the air engine, thus dispensing in a great measure with manual labor, both as regards "putting" and "hauling" the coals.

3. Compressed air at 40 pounds pressure has been successfully tried at Ryhope for airing a stone drift or tunnel, and the results are summed up as follows:—(1) Economy as regards its application to any part of the mine; (2) Additional safety to the mine, inasmuch as there is more direct communication with, and control over, all parts; (3) Having a power so easy of application to any part of the mine, its use for all purposes where labor is concerned must necessarily follow.

When the Mont Cenis Tunnel had to be driven, the engineers, Messrs. Sommellier and Grattoni, at once recognized this power, and availed themselves of it, and, but for this, I have no doubt the completion of that grand engineering feat would have been retarded for at least five years. It not only served as the power for driving their rock drills, but it cleared away the smoke after blasting almost immediately, and enabled the men to resume work at the face of the heading without any unnecessary loss of time, and to get the *debris* at once cleared away. Every miner knows that the hanging of the smoke in the ordinary method very often keeps him away from the place of his work quite one-fifth of his time, so that this power not only permits much more work to be done, but admits of it being done in a healthy atmosphere instead of in a vitiated one. At Mont Cenis Tunnel, too, they got this power very cheaply—at merely the cost of the machinery; a mountain stream running down near the mouth of the tunnel was utilized, and supplied the power of compressing the air. M. Derilley has published an elaborate and most valuable report on the work done at this tunnel, and much information is given therein respecting their method of compressing the air.

M. Trasenter professor of Mining at the University of Liege, considers that great advantages must ensue from the use of this power for driving engines at high speed in the galleries or working places underground, through the freedom from heating and condensation, slight friction in the pipes, and the ventilation in the works; but while enumerating its advantages we must not fail to look fairly in the face what are considered to be the drawbacks to its general adoption. M. Trasenter says compressed air necessitates costly works, and if used without expansion, it leads to a great loss of power owing to the necessity for conducting the air at the required pressure. In calculating the ratio of the energy

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expended in compressing the air to the useful work theoretically given out, M. Trasenter has laid down a simple and interesting formula. The work given out soon reaches a limit which cannot be exceeded, whatever may be the pressure of air, or the energy expended. The maximum of work given out (increasing the compression indefinitely, and without taking into consideration the elevation of temperature due to this compression) cannot exceed the energy given out by the volume of air caused by the piston of the blowing cylinder working with an effective pressure of one atmosphere, and he demonstrates the law, and goes on to say that the power which a cubic metre of air, compressed to a million atmospheres, is capable of yielding, without taking the rise of temperature into consideration, can never become double that which the same quantity of air, compressed to two atmospheres, is capable ot yielding. Air compressed to four atmospheres will give out a power proportional to (1——¼), or ¾, whereas to obtain a power equal to 1 a compression infinitely great is necessary He gives a formula which expresses the ratio of the work done to the power expended. This power is not a new discovery; Hero, of Alexandra, was in some measure acquainted with it, as well as with the knowledge of steam as a motive power. Hero's tutor, Clestibius, is said to have discovered that air was compressible, and the pupil is credited with having written a book on pneumatics, showing that when air was compressed it decreased in volume, and expanded itself again when the pressure was removed, Experiments proving its "ponderability" were made in the 17th century by Galileo and Torricelli; about the same time too, Guericke invented the air pump. Its chemical properties, however, did not engage much attention until another century had elapsed, when Black, Priestley, Laviosier, and others took up the subject, and great discoveries resulted from their labors. Papin, about the beginning of last century, had an idea of working an engine with air, generated by a water-wheel and compressing pump at a distance, but it was not brought into practice; and just one hundred years before the Mont Cenis Tunnel was commenced, one Isaac Wilkinson obtained a patent for a machine for compressing air very similar to the one employed at those works. It is generally known that when air or other elastic fluid is compressed, there is generated an amount of heat which is the exact equivalent of the force employed in the compression.

It may not be out of place here to give an extract from Professor Tyndall's valuable work, "Heat a Mode of Motion." He says:—"Whenever friction is overcome (by compression or otherwise) heat is produced, and the heat produced is the exact measure of the force expended in overcoming the friction. The heat is simply the primitive force in another form, and if we wish to avoid this conversation we must abolish the friction. We put oil upon the surface of a bone, we grease a saw, and are careful to lubricate the axles of our railway carriages. What is the real meaning of these acts? Let us obtain general notions first, and aim at strict accuracy afterwards. It is the object of a railway engine driver to urge his train from one place to another; he wishes to employ the force of his steam; it is not his object or interest to allow any portion of that force to be converted into another form of force which would not promote the attainments of his object; he does not want his axles heated, and hence he avoids as much as possible expending his power in heating them—in fact, he obtained his power from heat, and it is not his object to reconvert by friction the force thus obtained into its primitive form. For every degree of temperature generated in his axles a definite amount would be withdrawn from the urging force of his engine. There is no absolute loss. Could we gather up all the heat generated by the friction, and could we apply it mechanically, we should by it be able to impart to the train the precise amount of speed which it had lost by the friction. Thus every one of those railway porters whom you see moving about with his can of yellow grease, and opening the little boxes which surround the carriage axles, is, without knowing it, illustrating a principle which forms the solder of Nature; he is unconsciously affirming both the convertibility and the indestructibility of force. All the force of our locomotives is derived from heat. When a station is approached—say, at the rate of 30 miles an hour—a brake is applied, and smoke and sparks issue from the wheels on which it presses. The train is brought to rest. How? Simply by converting the entire moving force which it possessed at the moment the brake was applied into heat."

This heat in actual practice, is to a very considerable extent lost by radiation from the receiver and pipes in use; and further, when this compressed air has fallen to the temperature it possessed prior to its being compressed, it has lost in cooling an exact equivalent of the power expended in compressing it. Where, then, is the power to perform work? This remains in the stored-up air in the reservoir, where it is held under considerable pressure, and when allowed to expand in a working cylinder its temperature then falls below that of the atmosphere, and thus developes the work demanded from it. In accomplishing this, however, there is a loss of about 30 to 40 per cent. in consequence of the temperature of expansion not being depressed in an equal proportion to the increase obtained during its compression; and hence when the air has done its work in the cylinder, and issues forth from the exhaust passage, it is exceedingly cold, being about 28½° Fahr. or 3½° below freezing point. This intense cold formed for a considerable time very serious objections in its practical use as an engine motor, through the formation of ice as the exhaust. Various methods have been resorted to to remedy this defect, but this is effectually accomplished by casting the cylinder so as to have the exhaust openings connected with the exhaust port vertically and open across the cylinder, so as to discharge the air downwards as well as upwards, and admit of a bar being passed through, if necessary, to chip off the ice. It would appear from the foregoing that the higher the air was pressed, the greater would be the loss in the economic result; but in this there is a great difference of opinion, one party going in for slow speed and low pressures, not above three atmospheres, and another for high speed and high pressures. It is a very common expression, and true, that circumstances alter cases, and so, in my opinion, it is in this the "battle of pressures."

One does not wish to be dogmatic in this matter. Douglas Jerrold once said that dogmatism was grown up puppyism; and there is a proverb which says that a certain class of people, the opposite to wise, rush in where angels fear to tread. Where the work, however, to be accomplished is of a temporary nature, such as tunnelling, deep well sinking or boring, high speeds and high pressures may be adopted with advantage, as it admits of smaller machines being used to do the desired amount of work, but where the power is required for the running of a colliery to extend over 20, 30 or 40 years, and the air to be carried to long distances for hauling, pumping, rock drilling, and coal cutting purposes, then, I say, put down a good compressing plant, with moderate speed, ordinary pressure of (say) three atmospheres, and plenty of margin. This is the writer's view of the matter, and must be taken for what it is worth. An athlete, in running a hundred yards race, starts away at a very different speed to what the one does who is in for a mile race.

Looking at the matter in this light, the Kingswood Coal and Iron Company ordered a pair of air compressors from Messrs. J. Fowler & Co., of Leeds, of the following dimensions:—The steam cylinders are 36 inches diameter, the air cylinders being 40 inches diameter, with a 5-feet stroke. The air cylinders are immediately behind the steam cylinders, and fixed to the same bed plate; the piston is continuous, but so arranged that no part of the rod that works in the steam cylinder shall enter the air cylinders, or even the stuffing box. The air cylinders are cast with square ends and flanges to attach flat plates vertically at the sides thus forming a tank or receptacle for a complete jacketing of cold water, the object of the cold water being to keep the temperature of the air as low as possible during compression, the top left open to allow of evaporation and radiation. The supply of cold water is kept up by a pipe at the under side, getting its supply from a reservoir at a higher level than the tops of the cylinders, and the heated water is passed off at an overflow pipe at the top, the inlet and outlet being regulated by taps. The air is forced into a receiver, which is nothing more than an ordinary egg-end boiler, 25 feet long and 5 feet in diameter, fitted with stop valve and safety valves, the latter weighted to 40 lbs. per square inch. Steam is supplied at 40 lbs. per square inch, and the pressure of air stands at 45 lbs. per square inch; the steam is cut off at ¾ of the stroke; the fly wheel is 21 feet diameter, and weighs about 24 tons. From the receiver towards the shaft an old boiler tube, 28 feet long, 2 feet 10 inches diameter, is utilized, and from this cast-iron pipes 8 inches diameter are carried down the shaft for 225 yards; at this depth, and in an opening in the side of the shaft, a pumping engine is fixed and driven by the compressed air. This engine consists of a pair of air cylinders, 10 inches diameter and 2 feet stroke, which drives a pair of rams 6 inches diameter geared 5 to 1, with air pressure at 40 lbs., and delivers 160 gallons of water per minute 700 feet high. The out and out dimensions of this pump are 15 feet long, 7 feet 6 inches wide, and 6 feet 3 inches high. These compressors and pump, made by Messrs. Fowler and Co., of Leeds, have given the most unqualified satisfaction. The air pressure at this point, more than 250 yards from compressors, stand at 2 lbs. higher than it does in the receiver at surface, and my experience is that the pressure increases about 1 lb. for every 100 yards of depth. We have tested this by changing guages; the same also has been observed by Mr. Snape, engineer, and Sir George Elliot, who has had more than 11 years' experience with compressing machinery. I do not intend here to account for this, but merely state the fact. What is wanted is for the engineer (mechanical) to help us to produce this power as cheaply and so economically as possible. We want to have as little clearance at the cylinder ends as can be done with safety. Then the valves require great consideration, so as to admit the air as freely as it can be effected, and closed on the return stroke quickly. A great many valves have been brought forward, but one of the best I have seen is that of Mr. Chas. Pilkington and Mr. James Forrest, of Haydock.

The time allotted will not permit me to mention, much less to give a description of, the many makers and the many machines adopted for compressing air, and I will, therefore, briefly recapitulate some of the uses to which this power may be applied, and its advantages in mining.

1. It is a pre-eminently convenient power—you may use it for pumping purposes in your downcast shaft, and the exhaust will be an auxiliary to your ventilation. In the Speedwell Pit, in one hour after the pumps were set to work, it was found, by careful experiments made in indicating the temperature at surface, midway in the shaft, at pit bottom, and at 100 yards from the shaft in the main branch, that the temperature of the whole ventilating column was lowered just 3°; we find it also increases the volume, for the cold column given off at the exhaust, and thrown directly into the shaft, produces in the downcast precisely what the steam jet does in the upcast. Now, if one pair of 10 inch cylinders, running about 200 feet per minute, piston speed, does this, what will be the advantages gained by some half dozen such engines in the interior of the mine? and the air exhausted, too, would be comparatively very pure, not having been contaminated by any noxious gases, effluvias, or charged with coal dust, as must naturally be the case with the ordinary air in the mine; it having been simply passed along the pipes from the surface and through the air cylinder, the latter being lubricated with glycerine, nothing injurious could be obtained from that source.

2. By means of portable hauling engines driving either fall ropes, endless ropes, or single ropes, as in working to dip, will supersede horse and the heaviest of the boy labor.

3. For coal-cutting machines and rock-boring this will perform the hardest part of the men's work. There is a great deal of sinking or tunnelling—that is, cutting across the strata from one seam to another; it is a very common practice to work it in three shifts of eight hours, and boring the holes preparatory to blasting is certainly very hard labor. In driving these tunnels you have to divert a portion of your ventilation current, and send it in a 12 inch tube to air the working face; this is often a very feeble supply, and hence the tunneller has too often to do this hard labor in a close warm atmosphere, putting an additional tax on his health and strength; and you will find eight out of every ten men who have worked for any time at this particular class of work suffering from asthma or other chest diseases.

Now, with a small rock-drill, of which there are some 20 or 30 in the field driven by compressed air, the hard labor is dispensed with, and the ventilation accomplished. Assuming you have the pipes with the power conveyed along the mains, you have only to lead and connect a flexible tube from the pipes, and with your rock drill at the face of the drift set your borer to work and they will drive more ground in eight hours than three shifts of men in twenty-four hours, so that instead of having skillful men engaged the whole twenty-four hours, you only require them for eight; the other sixteen hours ordinary laborers may be employed clearing away the *debris*. The rock-drills, if fixed on a small carriage, may be run to the face on rails, and as soon as the holes are bored and ready for charging, the carriage is pushed back, and the shots fired. The flexible tube is then disconnected from the machine, and allowed to blow freely on to the face, and in a few minutes the place is cleared of the smoke, the *debris* cleared aside, and the drills set to work again. To reach our deep-lying seams, I believe it will be found that the best method of doing so will be by sinking tips or shafts from some convenient part in the interior of the mine, and I would limit shafts to 500 yards deep. If I had time I would give you my reasons for placing this limit on the depths of shafts, but will do so at some other convenient time. This power, therefore, is just the thing to accomplish this. Again, this power is particularly desirable in fiery seams. How difficult it is ofttimes to clear out a little gas lodging up in some holes in the roof of the roadway where a fall has taken place, or in filling up old and disused roads a space has to be left as a ventilating medium until within a few yards of the heading, and then gobbed up tightly or otherwise; that space so left is a reservoir for gas, these being ofttimes not more than 20 yards apart. You can understand that in a large colliery what a number of reservoirs there are, and this gas under pressure is very insinuating, and where a long roadway has had to be stayed, and the part with the close stopping toward the heading—that is, the barrier between the heading and what has become a reservois of gas—is not securely made, one can understand why a colliery explosion, such as we too often read about is of such a disastrous character.

Now with a flexible tube such as used with the rock-borers you may clear away the gas lodging in the hole in the roof, and you may also take it with you into the old road to be filled up, and stow the place tightly, leave no such reservoir as I have described, and leave the additional receptacle for rubbish, which otherwise you would probably have to send to bank. These are a few of the uses to which this power may be applied. It is very essential, too, in applying your underground haulage that you should have a thoroughly good, strong, and compact hauling engine. More depends

upon this, perhaps, than you are aware, and no one knows better the value of a good engine than those who have had to contend with a badly constructed one, especially when it is an underground engine. The engine should be self contained, and built upon a wrought-iron frame so that in the event of the bottom heaving or "pucking" there should be no cross strains and no snapping of bed-plates. All the working parts, especially those requiring the most attention, should be so arranged that free access may be had to them for oiling and repairs. The out-and-out dimensions should be kept within the smallest possible or practical limits—in fact, the utmost simplicity should be observed, so that any repairs requiring to be done may be attended to at once by the ordinary engine driver in charge. If every time any slight repairs were necessary, a skilled mechanic has to be sent for, it would often happen that half a day's work of the engine would be sacrificed for what might have been remedied in ten minutes, and one of the best that I have yet seen to meet all those requirements is that just patented by Mr. Henry W. Lewis, called his patent surface and underground haulier, and manufactured for him by the Treherbert Engineering Company, Glamorganshire. As an instance of its compactness, I may mention that a pair of 8 inch cylinders, 13 inch stroke, with two solid cast drums, each 2 feet 10 inches diameter, 9 inches wide and 9 inches depth of flange, complete, measures inand out dimensions, 5 feet 8 inches longby 5 feet 5 inches wide and 5 feet high; 6 feet high for the engine house would give ample room for lifting the drums out of their bearings and ungearing the wheels on account of the drum shaft, plummer blocks, and the crank shaft being set at reverse angles. There is another important feature, too—that is, the driving wheel is keyed upon the clutch, and thereby travels with the clutch, and one clutch serves for both drums. In working on the tail rope system a careless engine driver may by accident, when there are separate clutches, put both in gear at the same time, and the result would be something similar to two railway trains trying to pass each other on the same line—a smash up. By this clutch arrangement such a contingency is impossible, as by putting one drum in gear the other drum is put out of gear.

A great deal has been said and written with reference to the low percentage of useful effect in this power, but I have never yet seen this part of the subject treated fairly. It is said that only about 30 per cent. of useful effect is obtained from air engines; this I am prepared to admit if you are going to place an air engine side by side with a steam engine in a place favorable to the latter, and thus draw the comparison, but the useful effect must be calculated in a different way. In the first place, it is only intended to be employed where it is impracticable to use steam; and if under given circumstances, where ventilation has to be considered, you place to—

Steam disadvantages	30 per cent.
Air advantnges	30 "
Useful effect of air engines compared with steam	50 "
Difference of loss by condensation, radiation, &c.,	40 "
Total	110 per cent.

You have then most decidedly a difference in favor of air; and, lastly, when this power becomes better known and more favorably produced, if not used exclusively for ventilating, it will become a most powerful auxiliary, and it may be that a disused shaft, set specially apart for the purpose, will be used as a reservoir and receiver, so that when any atmospheric changes indicate that an extra supply of air is required, there shall be some ready means at hand to supply the want, and perhaps ward off a disaster which would otherwise usher, without one moment's warning, hundreds of our fellow-creatures into another world.

Bridling the Mississippi.

The St. Louis *Republican*, in a brief review of the work and money spent upon the delta of the Mississippi since 1819, sums up the expense to the people of the United States of keeping the mouths of that troublesome river open at four and a half million dollars before Captain Eads took the job in hand, and over forty-five millions since. Now, as we have seen, it appears from Captain Eads' own statement that there is imminent danger of the deflection of the Mississippi into the Bayou Atchafalaya, by which it would gain the gulf in six miles, instead of 340 as at present. The result of this change would be not only the ruin of New Orleans, which would be left high and dry, an insignificant inland town, but the permanent submerging of the richest portion of Louisiana under the mighty flood. The whole of the territory south of Berwick's Bay would be covered, while Morgan City and all the villages, towns and rich sugar plantations in Southwestern Louisiana would be swept away like straws in the tide.

The danger is so near and threatening that it becomes the vital question now before the people of the Gulf States. Most of their business interests are identified with New Orleans, and their prosperity falls with hers. The Atchafalaya, or "Old River," is supposed to have been, centuries ago, the outlet of the Mississippi. It is now a bayou of tremendous power and directness, and is invariably the first to overflow in the yearly floods of the 120 mouths of that river. The citizens of Southwestern Louisiana, it appears, prophesied this danger when Eads first proposed to build jetties into the outlet of the river. They warned him that the contraction of the bed of the river at the sides would force back the flood before it would sufficiently deepen its channel, and that the flood thus driven back would seek outlets above. They do not hesitate to assert that the vast flood of 1882 and its frightful devastations were mainly due to this cause.

Whether this charge is correct or not, it is a fact that since the jetties were built one-fourth of the high water volume of the Mississippi passes through the Atchafalaya instead of one-tenth as heretofore. Captain Eads himself states boldly that "the entire river will go out at Atchafalaya through 'Old River' within a very short period unless prevented by proper works at the head of the Atchafalaya." These proper works are estimated to require an expenditure of $150,000,000.

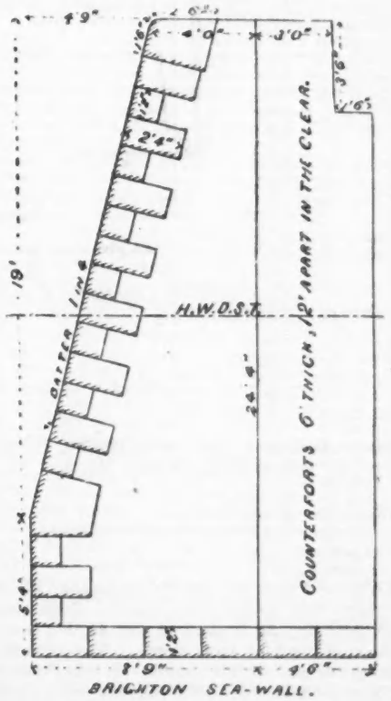
Whether the job will be given to Captain Eads is undetermined. Certainly not, if the people of Louisiana have any voice in the matter. Captain Eads' reticence with regard to this inevitable result until he had finished his first job, requires, they think, explanation. Should the river turn into this new channel, he states, it would be impassable for ships, as the mouth of the Atchafalaya is more obstructed than were the mouths of the Mississippi before the jetties were built. In that case the Mississippi would be practically without any navigable outlet to the Gulf of Mexico.—Philadelphia *Press*.

Preparation of Building Blocks from Furnace Slags.

A method is in use at the Königin Marienhütte, at Cainsdorf, in Saxony, for making building blocks from furnace slags. The method is based on the fact that, if a large lump of solidified slag is broken by hammering, the pieces from the interior are always considerable tougher and stronger than the outside. A pit is made, lined with suitable brick or stone work. The bottom consists of a cast-iron plate, 2 inches thick. On this plate stand iron blocks or carriers, 2 inches high, which support another iron plate having holes 2 inches in diameter left in it. On this perforated plate are placed the molds for the slag blocks, so arrange that each mold stands over one of the perforations in the plate, the molds themselves being open at the bottom and top, like molds used in making bricks by hand. After the molds are placed on the plate they are covered over by another plate or plates, with similar perforations, one to each mold. The slag is allowed to flow into the pit and down on to the bottom plate, rising up and filling the space between this and the plate under the molds, and passing into the latter through the perforations. The liberated gases escape through the perforations in the plate covering the molds till the slag rises high enough in the pit to cover this plate and flow into the molds also from the top. The slag is allowed to rise at least 2 inches above the top plate, and then the mass is left to cool slowly for 36 or 48 hours, according to the size of the pit, after which the slag blocks are broken out. The blocks so prepared are said to be very good, and are used for pavements, for building, etc. Even very basic slags and blast-furnace slags are stated to make very serviceable blocks under this treatment. Instead of a special casting pit for the blocks, the slag wagon may be used by putting the iron blocks or carriers on the bottom of the wagon and then placing the mold between two iron plates, as above described.

Flint-faced Sea Wall at Brighton, England.

The Engineer, (Feb. 13, 1885,) gives a description of the sea-wall recently built for the purpose of protecting the beach between the parishes of Brighton and Hove, England, under the designs of Sir John Coode and Mr. Ellice Clark. The foundation has been started 2 feet 4 inches below Ordnance datum, on the shingle, but at a distance so far within the existing beach line that there has been no fear of the shingle foundation being damaged by underscour. The wall is described as being a handsome feature, being executed in a finished style with massive granite copings, and will be guarded by ornamental iron railway. The wall itself is 8 feet 9 inches thick at the base, tapering with a batter of 3 inches to the foot, to 4 feet of top width. At intervals of every 12 feet it is strengthend by counter-forts 6 feet in depth and 4 feet 6 inches wide,

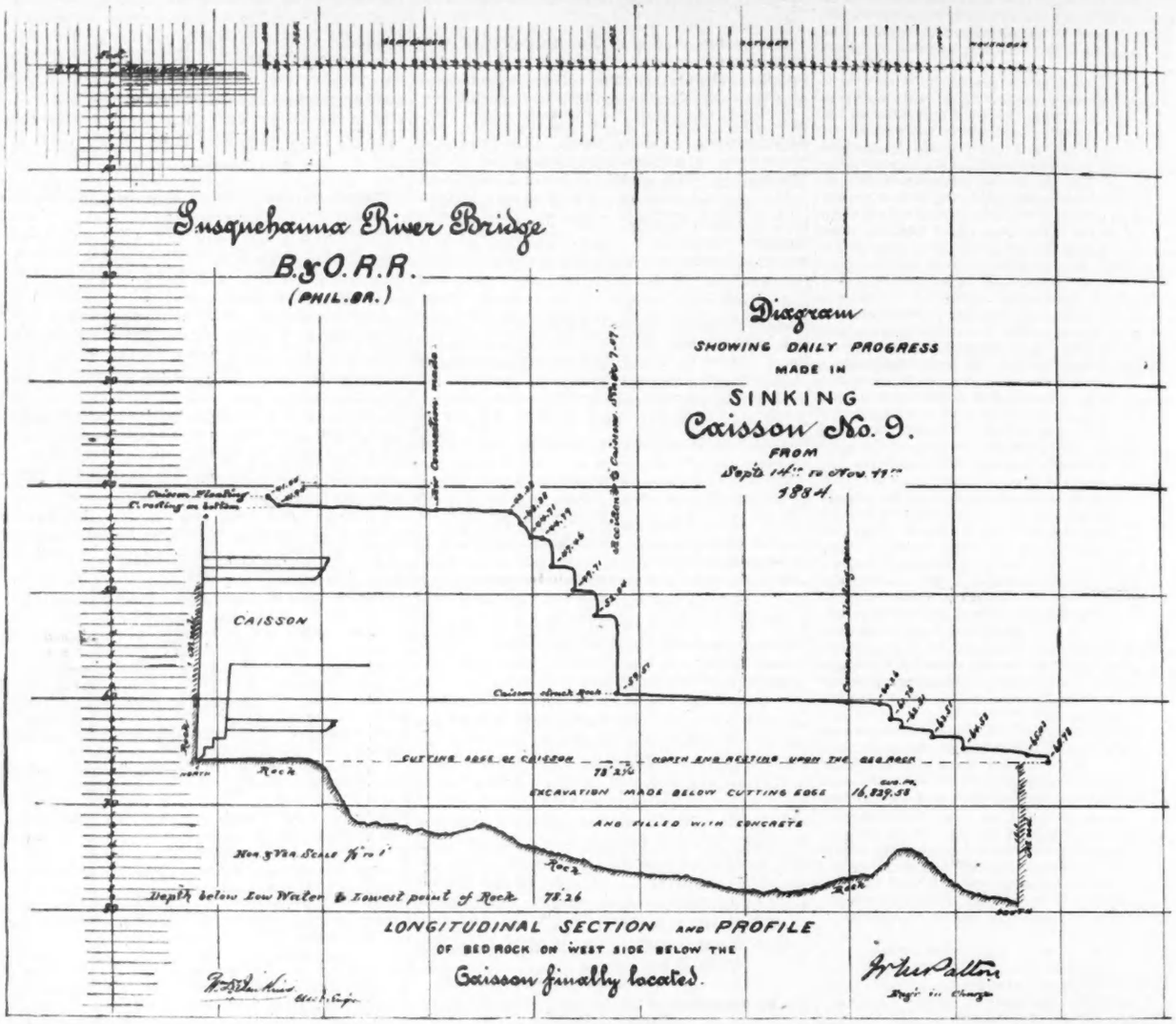


BRIGHTON SEA-WALL.

while steps and inclined landings and safety stages for boats and bathing machinery in rough weather are provided at intervals. The material used throughout the work is concrete, laid *in situ* in courses, the wall being faced seawards by moulded blocks of the same material, these being themselves faced with large flints carefully pointed with Portland cement. It is claimed that this novel method of facing concrete work not only gives a neat and finished appearance to the work but that it is also an efficient protection of the concrete work against erosion by the water. The extreme batter of 1 in 4 was adopted with the object of inducing the beach to form itself into a line of low curvature against the wall—an object which has already been manifestly attained. The total length of this wall is 2,100 feet.

ENGINEERING NEWS Three months for One Dollar.

B. & O. BRIDGE, HAVRE DE GRACE, MD.; PROGRESS DIAGRAM OF PIER 9.



Caisson-Sinking at the B. & O. Bridge, Havre de Grace, Md., (Caisson No. 3.)

Written for ENGINEERING NEWS.
BY COL. WM. M. PATTON, ENGINEER IN CHARGE.

(Continued from page, 84.)

Caisson No. 3, of the Susquehanna River Bridge, was commenced April 4, 1884, and launched May 20, framed as far as the completion of the first deck course. The launching weight was 431,362 pounds. It was floated into position May 31, deck courses completed June 13; commenced concreting July 10, and finished August 11. 1,874½ cubic yards of concrete were put in place, an average of 58½ cubic yards per day. Air was admitted to the caisson, July 14; false-bottom removed by the 19th and commenced "blowing-out" material on same day. The caisson reached the boulders on August 30, with the cutting edge 68.06 feet below low-water. On Sept. 9, commenced sealing with concrete under cutting-edge, this being then 70.72 feet below low-water, and on Sept. 20, completed the filling of the air-chamber. The chamber contained 401 cubic yards, an average of 32 cubic yards placed per day. By Sept. 25 all the shafting was removed, and by the 27th the shaft-holes were filled up with concrete.

As in caisson No. 2, the material passed through was of a very sandy nature; no pump was used and the debris was removed entirely by the "blowing out" pipes. For the concrete in the crib, 1 cement to 4 sand was at first adopted, but, although satisfied by previous tests that the Alsen Portland Cement would easily carry the first named proportion of sand, this was changed to 1 cement to 3 of sand. The top layer of concrete was made 1 cement to 2 parts of sand. The average yield was 1 barrel of cement to $1\frac{13}{100}$ cubic yards of concrete.

Owing to the frictional resistance and so as not to be forced to reduce the pressure too much, more weight was required and on Aug. 16th the masonry was commenced. At this date the weight of timber, iron and concrete was 8,465,871 lbs.; the buoyant effect of the compressed air was 6,032,989 lbs.; the total resistance was thus 2,432,882 lbs. The surface of caisson and crib below the bed of river was 8,533 square feet, and the frictional resistance was 285 lbs. per square foot. The air-pressure was 30 lbs., reduced while sinking to 20 lbs.

On Sept. 6, the air-pressure being 32½ lbs., the weight of crib, etc., being 10,071,300 lbs., and buoyant effect same as above, the total frictional resistance was 4,038,311 lbs. The surface below river bed was then 10,672 square feet, and the friction, 378½ lbs. per square foot. This resistance increased rapidly after getting into the boulders but could scarcely be considered as uniformly distributed.

An open caisson, 16 feet high, was used, built in one section with only two thicknesses of sheeting plank, and vertical rods 1¼ inch in diameter; otherwise the construction was the same as for the higher dams already described. In filling the air chamber the concrete was mixed by hand; the proportions used being 1 cement to 2 sand and 12 well filled barrows of broken stone; this yielded $1\frac{13}{100}$ cubic yards of concrete. One-half barrel of cement mixed to a concrete as above constituted a "charge" and was passed through the supply shaft at one time.

The great mass of the boulders found were thoroughly washed and then well bedded in mortar forming a solid rubble base on which the concrete rested. The yield per barrel here quoted includes concrete proper and the boulders thus imbedded. As No. 2 caisson was settled slightly out of position, an attempt was made to gain the distance by keeping the west side of caisson No. 3 higher than the east, in the hope that at each levelling of the caisson a gain to the west would be secured. This end was not accomplished, and the reason suggested was that as most of the material removed from within was deposited on the west side, an eastward motion was due to the pressure caused thereby. There were only 10 feet of water and the material never rose above the water surface, and it hardly seemed possible that the slight difference in pressure, of water on one side and water saturated material on the other, would be sufficient to cause any decided motion in the immense weight of of the caisson and load. But the eccentric movement in caisson No. 3, has convinced the author that this disposal of the debris was the true cause of the trouble. The material in this caisson was discharged mainly through two pipes, one situated on the N. W. and the other at the S. E. corner, and the excess of pressures at these corners formed a right-handed couple pressing the south end of the caisson to the west and the north end to the east of the true axis. This means of moving the caisson in either direction was subsequently

adopted successfully in regulating the sinking of the caissons.

The accompanying diagrams* show the daily rate of sinking. No blocking up under the cutting edge of this caisson was resorted to.

The total timber in caisson No 3, was		215,565 feet	B. M.
" " " "	crib " "	197,910 "	"
" " " "	coffer-dam " "	31,517 "	"
	Aggregate	444 992	
Total Concrete in Crib No. 3. was		1,893 $\frac{33}{100}$ cubic yards.	
" "	Air-chamber,,	400 $\frac{75}{100}$ "	"
	Aggregate	2,294 $\frac{08}{100}$ "	"

The displacement or excavation in sinking caisson (making no allowance for inflow of material) was 123,401 $\frac{83}{100}$ cubic feet. The depth sunk below low water was 70 feet, 8$\frac{3}{4}$ inches; average depth sunk per day, 1 $\frac{33}{100}$ feet; the iron used was as follows.

Screw bolts, nuts wrt. washers etc....	15,651 pounds.
Drift-bolts.....	36,832 "
Spikes.....	700 "
Cast-washers.....	2,572 "

The number of barrels of cement used was 1734, and the yield per barrel in crib and caisson was 1 $\frac{33}{100}$ cubic yards; the concrete in this estimate meaning the mass formed with concrete proper and the large stones imbedded in the successive layers.

TO BE CONTINUED.

CORRECTION. In the previous paper on "Caisson No. 2," several errors of proof-reading appear. The measure of material excavated should be 112,124 cubic feet, not "cubic yards;" and the date of the completion of the filling of the air-chamber should be July 10, not "July 8th."

*NOTE: As these diagrams are practically uniform in design, we have selected for illustration the diagram of Pier No. 9, showing the method of keeping the progress notes.—ED. ENG. NEWS.

Sewer Appurtenances.

Notes of discussion at meeting of Connecticut Association of Civil Engineers and Surveyors, held Jan. 13, 1885, at New Haven, Conn.

Mr. C. A. Ferry, Assistant Engineer, in charge of the sewerage of New Haven, said their manholes had brick walls 12 inches thick, and that in pipe sewers the brick work was begun on a level foundation below the bottom of the sewers.

The invert is built with the same form as that of the pipes entering it.

The interior of the manhole becomes level in plan at the height of top of sewer. A part of the form of arch of the pipes extends a short distance into the manhole at each end, so that a portion of the water does not strike a square bulkhead at the lower end of manhole, as would otherwise be the case, but the form of the upper half of the sewage, when sewer is full, is gradually changed from a rectangle to a semicircle. Straight galvanized iron steps are used

Manhole covers are not perforated, for several reasons. On earth streets, in summer, sand and mud washes through the holes, greatly to the detriment of the sewers. In winter, when there is snow and ice on the ground, they are either wholly useless, or if they thaw off the ice, they make a bad place in the street. In narrow streets, with high buildings, in foggy weather, the air from sewers would stand in the streets to the detriment of the comfort and health of the passers by. If a disease like cholera were present the danger of contagion would be greatly increased by perforated covers.

All plumbing should be protected by traps, and should have fresh air inlets, and with soil pipes carried through roofs, in which case, danger from bad sewer air would be removed.

Sewers properly constructed and flushed would not generate dangerous gases to any great extent, and if such gases were in the sewer that was the place to keep them.

In answer to question as to best mode of ventilating sewers, if they were to be ventilated at all, he said, that in his opinion, separate pipes leading from every house drain on the sewer side of traps to a point above tops of houses would best answer the purpose.

Lampholes are but very rarely used, manholes being put in at all changes of line or grade. They use what is known as the Brooklyn catch basin. They are eight feet deep and five feet in diameter except near the top, where they are four feet. A water trap is formed by building a flag into the walls. The bottom and walls are 12 inches thick. Their capacity for sediment is about two yards.

A granite head in five pieces is used, costing about $60, including gratings. The sediment is removed through an opening in the gutter covered by an iron grating. About 3000 brick and seven barrels of cement are used in their construction, and the total cost is about $100.

Hubs are set fifteen feet apart on each side of the sewer, and are located from nearest manhole below. No subsoil drains are used.

Pipe sewers are cleaned as follows: A monitor watering cart holding 700 gallons, and provided with a valve opening 16 inches in diameter, is driven over a manhole and after being filled from a neighboring hydrant is discharged into the sewer through two telescoping sections of galvanized iron pipe. The upper pipe has a funnel to receive the canvas hose, and below the funnel is 10 inches in diameter. The lower one is 11 inches in diameter, and has a nearly one-quarter turn at the bottom to direct water into sewer. In order to increase the scouring force of the water, a cylindrical wooden ball, with the ends turned off so as not to catch on projecting points, and having a diameter two inches less than the sewer, is placed in mouth of sewer. This ball is carried forward by the water, which in case any obstruction is met, passes under and around the ball. To provide against the ball's becoming wedged into the sewer from any cause, a strong cord is attached to it and passed through the galvanized pipe and wound on a reel.

Brick sewers are cleaned by men passing through them. The material is taken to the manholes in buckets, run on specially designed trucks. These are so arranged, as to run in any sewer from 24 inches in diameter upward.

Mr. Bunce, the city engineer of Hartford, contributed the following notes regarding their sewer appurtenances.

Manholes are circular in plan with an internal diameter of three feet at the bottom, and 22 inches at the top with eight-inch walls. The frame and cover weigh 350 lbs., and costs $10.50. Covers are perforated.

No steps are used.

Manholes, complete, cost from $30 to $40 according to height.

No lampholes are built.

Catch-basins have 12-inch walls, and are trapped with water-traps formed by building a bluestone flag into the basin walls.

The basins, complete, cost from $50 to $60.

Two men and a one-horse cart are kept cleaning basins all the while, except during the winter. The basins are connected with the sewer by ten-inch pipe.

Hubs are set on each side of the sewer 25 feet apart, and generally with their bottoms one course below the top of invert.

Sewers are oval in form up to 30 inches in diameter. Above that size they are circular.

Mr. L. W. Burt, Civil Engineer, of Hartford, gave an interesting description and illustration of a large trap, built at upper end of a large culvert enclosing a brook. The culvert was about ten feet wide.

The trap was built as follows:—Three piers were built forming corners of an isoceles triangle, the base of which was the mouth of culvert and the apex of which was in the center of stream above culvert. On the equal sides of the triangle were placed stone lintels 12 inches wide and 18 inches deep, with their bottoms a few inches below level of lowest water in the brook. The triangle was covered by springing two intersecting gothic arches from the lintels and turning them against the end of culvert. The brook under each lintel was excavated and paved in such a manner as to give a clear opening of about 12 feet in length and three in depth. This excavation and paving extended up and down the brook from the lintels with vertical reversed curves like a running trap. The trap had been wholly successful in not only shutting off the current of bad air but in discharging the very large amount of water passing through the brook at times and also in keeping itself clean and ready to do its work at all times. He also described an inverted syphon, used to carry a sewer underneath this same brook. A manhole was built on each side of the brook of sufficient depth to allow a straight connecting sewer to pass entirely underneath the brook. That part of sewer lying above the brook discharges into one manhole at the normal grade of the sewer, and the remainder of the sewer continues at its own grade from the other manhole.

Mr. F. F. Weld, City Engineer of Waterbury, said their manholes were ordinarily round in plan, four feet in diameter and decreasing regularly to manhole frame. Brick work begins full size at or below bottom of sewer; walls are eight inches thick; junctions of pipe sewers are made wholly within the manhole of as large a radius as possible. A manhole of average height requires about 1,600 brick. The frames and covers weigh 580 pounds and cost $12.00. The covers are perforated, and it is considered an important and effectual means of ventilating the sewers. Galvanized iron pails are hung under the perforations to catch the dust and mud that may fall through them. These pails are quite small at the bottom and large at the top, so that earth accumulating faster at one side cannot overturn them. The pails hang on a rod which passes across the manhole frame and rests on a flange near the bottom of frame. Cast iron steps are used, costing 2½ cents per pound. Manholes complete cost $30 to $35.

Lampholes are built of eight-inch vitrified pipe, with cover and frame.

Catch basins are built of eight-inch brick work and are 4½ feet in diameter and 8 feet deep. They are covererd with a granite head with two pieces, one in the walk and the other in the gutter. The former has a round opening, through which the basin is cleaned. The granite heads cost $27 to $35. The outlet is covered by an iron hood forming a water trap. The basin requires 1,800 to 2,000 brick and costs, complete, $110 to $140.

The sewerage of Waterbury is for the most part designed on the separate or restricted plan, and most of the catch basins empty into natural brooks.

Hubs are set twenty feet apart with their tops at, or one course below, springing line of sewer. Their location is taken from next manhole below. Vitrified invert blocks are used to facilitate the removal of the ground water and make a smooth surface for the invert.

All brick sewers are egg-shaped. Outlet is into the Naugatuck River. At the terminal chamber the large brick sewer drops and sewage flows out through 24-inch cast-iron pipe.

The sewers are cleaned by flush tanks, both set and portable, and by scrapers and especially designed truck and buckets.

One of these is described as follows:—The bucket is 8 inches in diameter and two feet long, with flaring mouth 10 inches in diameter, to the inside of which is attached a bail about 18 inches long. Scraper is made of No. 16 galvanized sheet iron with an iron band ¼ inch by 1 inch around outside of mouth.

The bucket is drawn through the sewer by means of a tripod derrick, with a single block, through which rope passes on its way to drum, on which it coils. A pair of carriage wheels are used in place of cranks, and on the completion of the work at one manhole the third leg is folded over and the whole turned down horizontally and trundled to next manhole with all the appendages loaded on it.

Where the rope turns a right angle to come up the manhole it passes under a sheave 6 inches in diameter and 1¼ inches thick, running on 1¼ inch rod joined to ¼ inch by 2½ inch band bent in the form of a half circle and fitting the arch of sewer. A turn buckle in the rod holds the whole firmly in place. Three men are needed, one at lower manhole to draw back empty bucket by a rope attached to ring in bottom of bucket, and the other two to man the derrick and dump the material brought up.

In answer to questions, Mr. Weld stated that all parties connecting with the sewers are obliged to put in a fresh air inlet near and on the house side of the trap. These are located under the sidewalk near the curb. A six inch pipe being brought up from the hand-pole of a P trap and covered in the walk with an oblong iron frame and cover. The cover is perforated at the opposite end from that under which the pipe comes up, thus allowing air to pass in, and excluding from the drain the earth which might fall through the holes.

Mr. E. P. Augur, said: The catch basins used in Middletown are built jug-shaped, nine feet deep in the clear, and six feet interior diameter. The walls are eight inches thick with double course of brick on the bottom. They are covered with a North River flagging stone four feet square, into which an iron cover of about twenty inches in diameter is countersunk. The trap is formed by a piece of curbstone set edgewise across the basin about four feet above the bottom, and built into the side walls. If necessary to give more height inside the trap, one or two courses of brick are laid on top of the curbing. When the brick work of the basin has been laid even with the top of the curbing or brick work on top of the same, a piece of flagging is laid over the curbing and side of the basin with a good bed-joint of cement mortar. The outlet pipe is usually placed so as to allow the water to stand about six inches above the bottom of the curbing, which forms the trap. The basins are plastered with cement mortar and washed with thin cement wash to a point just above the water line. These basins are never used as inlet basins, but the latter are built separately and connected with the catch basin with 10 inch culvert pipe They cost about $75.

The inlet basins are made of rubble stone masonry. The interior dimensions are: three feet long, two feet wide, three feet deep; walls two feet thick; flagging bottom and gutter stone, and flagging on top, with the ordinary style and size of opening cut through the curbstone for receiving the storm water. The manholes are similar in construction to those on the New Haven sewers.

Mr. Augur described a very cheap and simple style of inlet and catch basin combined, built of Vitrified tile of large diameter (about two feet) set endwise—in the excavations made for the same and bedded in concrete At the proper height for the outlet, a section is put on which has both an outlet branch and a trap formed upon it. The latter consists of a plane-shaped piece of earthenware—set obliquely to the longitudinal axis of the pipe and formed upon it as the pipe is made. Ordinary sections are then put on to bring the basin to the surface of the gutter. A grate of iron is set in the bell of the last piece of pipe—with a cushion or washer of rubber—under the grate. Paving stones are set for a little distance away from the basin. They do not cost more than $15 or $20 each, but must be more frequenty cleaned than larger basins. The grate openings would be liable to get stopped with leaves and rubbish, and fail to take off the water, which might be quite a serious objection to them.

Mr. William B. Rider, of South Norwalk, described and exhibited plan of catch basin designed by him for use in South Norwalk and other places. It is square in plan with flag bottom and side walls of eight inch brickwork. It is covered with a blue stone flag, through which an 18 inch hole is cut for cleaning basin.

The water passes into basin through space made by leaving out one curb the width of interior of basin. The gutter stone extends into and half way across the basin. A water trap is formed by setting two flags vertically across the basin. The top of the one, nearest the outlet is built against the under side of gutter stone. The bottom of the other is at the bottom of the basin. The trap is formed by the bottom of the former flag, being about six inches below the top of the latter flag. The plan exhibited had the following dimensions which can be varied to suit circumstances: length, four feet; breadth, three feet; depth, four and one-half feet; outlet pipe 15 inches in diameter. Sometimes the outlet pipe is put at one corner and the flags forming the trap are placed diagonally across the basin, giving greater capacity for sediment; sometimes, the basin is built partly under the gutter.

Mr. H. S. Whipple, of Birmingham, Conn., contributed the following notes:

The manhole is circular in plan with a diameter of four feet to within four and one-half feet of the surface of the street, and the wall is four inches thick. From this point the manhole is gradually drawn in, until it is twenty-two inches in diameter, ten inches below the surface of the street. The wall of this last section is eight inches thick. The average number of bricks used in manholes of an average depth of ten feet is 864. Average weight of cast iron head and cover is 440 pounds. Cover is perforated with twelve holes, three-quarters of an inch in diameter. Cost $29 without the head. Contract price in 1880, $20; contract price in 1882, $17. Total cost to Borough in 1882, $53.65.

Three-quarter-inch galvanized iron pipe is used for steps at a cost of $1.25 per manhole.

We have no lamp-holes.

Our catch-basins are built like those in use in the city of Providence, R. I. The walls are built of two rings of four inch brickwork with an inch of cement between the rings. Total cost including connection with sewer, $133.88. Cast iron trap head and gutter stones are of Westerly granite 10 inches thick and cost on the ground, $27.76.

We have no special appurtenances.

Hubs are placed opposite every house and for vacant lots every twenty-five feet on each side of the sewer. On brick sewers they are placed at the springing line.

We have used no subsoil or trench drains.

All our sewers are circular in shape.

No special form of outlet. The wall of the sewer where it enters the river being increased to twelve inches in thickness.

Sewers are flushed by filling a manhole with water from a public hydrant and allowing the water to escape with a sudden flush. Cost of cleaning and flushing 7,100 feet of sewers in nine streets, $18.20 for each cleaning.

Mr. C. E. Chandler, City Engineer of Norwich, Conn., contributed the following notes:

Our manhole for brick sewers is generally of four-inch brickwork, and begins at springing line of sewer with a width eight inches greater than the diameter of sewer, and a length at top of sewer of four feet. These two dimensions are soon reduced to a circle 30 inches in diameter, which holds to within 30 inches of the surface of ground, from which point it is drawn in to a diameter of 22 inches at bottom of frame.

In case of pipe sewers the manhole is similar except that it is begun on a brick invert four feet long, with the form of the pipe at the ends and somewhat enlarged in the center.

In some cases the manhole is round in plan at the bottom, with an invert of same form as pipe passing through it. This form is preferred.

Junctions of brick sewers are made with intersection wholly within the manhole. In this case manholes are five feet long and we thus get a straight Y branch or an angle of about 25 degrees. The branch sewer has a curve of large radius outside of the manhole. Here the manhole has an eight-inch wall to height where plan becomes circular.

All pipe sewers are laid on straight lines and junction curves are formed in brick work within the manhole.

U-shaped cast-iron steps are used.

Manhole frames are 20 inches in diameter and ten inches high. We are now using a cover with 16 three-quarter inch holes grouped near the center so that there may be a considerable space left around a pail hung underneath to catch any earth which may fall through the holes. No pails have been used as yet, but it is intended to use ordinary galvanized iron pails hung in a special cast iron ring with arms reaching the proper places in flange.

The cost of the average manhole is as follow:

850 brick at $18,	$15.30
Frame and cover, 265 lbs, at 3 cents,	8.05
Five steps, 11 lbs. each, at 3 c.,	1.65
Total	$25.00

Lamp-holes are used alternately with manholes when changes of line and grade are frequent. They consist of a twelve-inch cement pipe brought to the surface and covered with a cast-iron cover.

In brick sewer they begin at top of arch.

In pipe sewers an invert like that for manholes in pipe sewers, only smaller, say two feet long, is built, and the brick work drawn in as soon as practicable to a diameter of twelve inches, and the pipe is carried up from this to surface. They cost:

200 brick at $18,	$3.60
10 feet 12-inch pipe, at 40c.,	4.00
Cover, 50 lbs., at 3c.,	1.50
Total	$9.10

Our catch basins are round in plan, eight feet deep and four feet in diameter.

In front of the basin under the gutter stone a brick chamber, seventeen inches square and three feet deep, is built to receive some form of mechanical trap. This chamber is covered by the gutter stone. From the bottom of chamber, underneath the trap, leads the pipe to sewer. The water from the basin comes into upper part of chamber through an opening full width of chamber. The earth line is four feet three inches above bottom and the basin holds about two yards. The basin is always trapped, whether full, empty or being cleaned. The basin is covered with a bluestone flag, four feet square, with opening and iron cover. The water passes into basin through an opening eighteen inches by seven inches in a bluestone curb.

The basin cost as follows:

7 cubic yards excavation 40c.,	$2.80
800 brick, $18 per M.,	14.40
Gutter stone, 2 ft. 2 in. × 2 ft. 2 in. × 3 in.,	1.00
Curb, 5 ft. × 1 ft. 6 in. × 4 in.,	2.85
Flag, 4 ft. × 4 ft. × 3 in.,	5.25
Iron cover, 55 lbs., 3c.,	1.65
Trap, say	6.00
	$33.95

At intersections where water comes from two directions, instead of bringing the water past both crosswalks, we use two inlet curbs and gutter stones, one above the crosswalk on each street, and lead the water through brick channels eighteen inches wide and nine inches high, covered with flags to the basin located at some convenient point between the inlets. These channels are built straight so that anything which might lodge in them can be pushed into catch basin.

This increases the expense by

Extra curb,	$2.85
Gutter stone,	1.00
Extra stone over-trap,	.85
25 feet brick channel excavation, 10c.,	2.50
25 feet flagging, 15c.,	3.75
625 Brick, per M. $18,	11.25
	$22.20

Making basin with two inlets, cost, ...$56 15.

Regarding four-inch walls for manholes and catch basins I have never known but one case of failure on account of this, and that was the case of a basin in wet clay.

Where proximity to houses makes it desirible to have the basins tight, we pave the bottoms and plaster the sides to water line. As a rule our basins are not tight, mechanical traps making tightness unnecessary, except so far as soil pollution is concerned. Generally our houses are some distance back from the street, and it has been an open question in my mind whether the last water from a storm soaking into the ground appreciably affects the air in the vicinity.

The expense of cleaning is less, as there is no bailing to be done, and I think there is less likely to be an appreciable odor from the basins in warm weather.

It may be said, and I will admit, that the mechanical traps are not perfectly tight, and this raises the interesting question of sewer ventilation in general.

In 1879 we put in a sewer 4,000 feet long, on grades from six inches to six feet per 100, with fifteen untrapped catch basins. The sewer has never been artificially flushed, and I have heard no complaints regarding smells from the catch basins. I consider it the best ventilated sewer I know of, as the inlets are open in all weathers.

Yet, on the whole, I prefer that the manholes be perforated and currents of air be kept from coming up at the gutter, but I do not think it necessary that the traps should be perfectly tight.

The following table shows the cost of cleaning our basins the past eight years. The figures are furnished by our Street Commissioner, Mr. Mowry B. Cole.

Year.	No. of Basins.	Cost per Basin.	Total Cost.
1877	149	$1.12	$166.88
1878	150	1.76	264.70
1879	151	1.14	172.29
1880	181	1.36	246.73
1881	229	1.86	425.88
1882	243	1.82	442.34
1883	275	1.98	544.99
1884	292	3 10	933.53
	1,670	$14.44	$3,197.34

Average cost of Basin per year, ...$1.92.

The pipes connecting basins with sewers are usually ten inches in diameter. They cost about 65 cents per lineal foot.

We set hubs wherever proprietors order, and otherwise twenty-five feet apart. In brick sewers we generally put bottom of pipe at springing line of arch and at an angle of forty-five degrees with sewer. In pipe sewers, center of hub is at half the heighth of sewer. We cover them with cement covers put in dry. We use four-inch cement or Akron pipe underneath sewer for the double purpose of draining the trench during the progress of the work and removing the ground water afterward. We have one overflow chamber about 6 feet in diameter at bottom and drawn in to about two feet in diameter at top. It is divided into two compartments by a bluestone weir. A 36-inch sewer, with grade of 1 in 200, leads into one of them and the bottom 13½ inches of a 24-inch brick sewer leads out of it on same grade. The excess is discharged over the weir into the other compartments, from which it is carried away by a 24-inch sewer on a grade of one in 45. The center lines of the two first-named sewers form a continuous curve with a radius of 30 feet.

I have depended on the 36-inch sewer to bring in about 2,650 cubic feet of sewage per minute, and of this I expect about 625 feet will continue in main channel and 2,025 feet pass over the weir. On this I am open to correction. The water passing over the weir discharges at a point where much sewage might be objectionable and is put in for the purpose of reducing the size of main sewer.

One of our sewer outlets is through a bridge abutment, at the foot of which it would be objectionable to discharge sewage. We carry the sewage out over channel through iron pipe suspended underneath bridge, while the storm water drops on to rocks at foot of abutment. In another case we discharge storm water at river bank and carry sewage to channel through an iron pipe. In still another case storm water is discharged at high-water line and sewage is carried to low-water line through a small pipe.

Where our sewers have been properly built, flushing or cleaning has never been actually necessary, though for sanitary reasons I think it should be done periodically.

Statue of Liberty Enlightening the World.*

No one has thought it worth their while to ascertain who were the art critics, and by whom appointed, upon whose dicta rested the selection, of a fitting pedestal for the Statue of Liberty, presented by some French people to the American Nation.

We have almost from the inception of the project, certainly from the date at which it was brought prominently before the American public, seen this Statue of Liberty Enlightening the World, perched upon a high mass of material, supposed to be essential to the process of physical illumination—if not of the world, certainly of what we think a good part of it, and notably to the poor emigrant escaping from the oppression believed to prevail under the monarchial governments of Europe, who will hail this light as he approaches our coast as the harbinger of good things in store for him in this great land of liberty. Such is the sentiment supposed to be embodied in this monument. But the question naturally arises whether our matter-of-fact people will be likely to provide the costly establishment of steam dynamos, of no practical value otherwise, but sufficiently powerful to illustrate in a feeble way to the stranger seeking an asylum here, the poetic idea of the statue, which poetry he would find a great solace to him so soon as he had set foot on our shores. I had supposed that this illumination was to be purely figurative, as the addition of a mammoth electric light, to the torch in the hand of the goddess, would be a piece of realistic treatment, wholly subversive of the aim and object of a work of art. I trust that we have been misinformed as to the intention of the managers, whoever they may be, in this matter of the light, and that we may be spared this apothesis of 4th of July oratory. Presuming, that prostituting this work of art, to the every day purpose of a light house, was never seriously entertained, I proceed with a few brief comments upon the design of the pedestal, of which we hear so much lately, but strange to say, not one word calling in question the fitness of the design itself, or the necessity which exists for its completion as designed.

The height of the statue, measured from the

(*For full page illustration See ENGINEERING NEWS of Jan. 7th, 1885.)

foot to the crown of the head, is 116 feet; designed in the spirit of pure Greek art, as translated by a French artist; but passing that by, as but a slight blemish in an otherwise happy rendering of a grand conception, we might inquire what principles should govern in the design of a pedestal for such a statue? But previous to considering this, it may be well to state the general dimensions thus far determined upon. From crown of head to toe, as before stated, 116 feet. Thence to the platform of the terrace, 114.3 feet. This latter dimension would represent the pedestal, did the monument rest at this level of the terrace, (61.8 above low water) upon the summit of a mound, or island of the height of the terrace. All artificial constructing lines in that case, terminating at that level, and the eye would not naturally refer the entire elevation to tide level; but the scarp wall of the fort, being of comparatively limited extent, horizontally, and relieved against the water on all sides, and united by structural artificial lines with the superstructure, the eye insensibly refers the entire elevation to the bottom of the scarp wall as a base line. The occurrence at intervals of the salients and re-enterings in the scarp, favoring the idea of its being considered as a sub base to the monument. Adding this height to the above, and the pedestal with its sub-base is 176 feet, or more than once and a half that of the figure. I omit any consideration of the uplifted arm in this case as the bulk of the masses compared will render its effect insignificant to the eye.

A column surmounted by a statue, is one thing, and a statue resting upon a pedestal, is quite another. In the first, the column is the principal feature, to which the crowning statue is but secondary. In the latter, the statue is, or should be, the commanding feature, to which the pedestal is quite subordinate, and serves but to detach the statue from its surroundings. Where the statue is on a small scale, much latitude may be allowed in proportioning the two parts in this respect, with good effect; but as the scale of the work is increased, the pedestal should be kept down, and by no means increased proportionally, and when the statue is colossal, no rule can be observed, further than that, a due consideration of the surroundings should govern its dimensions.

In the proposed structure on Bedloe's Island (rejecting for the present the light house idea for reasons stated) the figure is holding high a torch. To whomsoever that torch is held as a figurative beacon light, the goddess must face. She cannot face the north—the attitude would be without motive. She cannot face the west—that would be equally so, unless it were intended to emphasize the late Horace Greely's advice to young men—"go West——you." She must therefore face either the south or the east. The south possibly, as welcoming, and ushering up the bay, the new comers to our shores. I should however prefer the east, for, if the statue has any figurative meaning, it is addressed to the people of the eastern hemisphere, as indicating to *them* especially, the entrance through which they may attain the blessing of civil and religious liberty. Suppose she faces the east. or the rising sun. Owing to her great height, she cannot be relished as an art production, when the observers is viewing the statue from a level far below; for I am assuming that it is the statue to which our attention shall be drawn, and not to her support. Hence the Brooklyn Heights will be the best shore point of observation; but even here the statue will not be seen to the best of advantage, as its foot, as designed, is nearly *three* times the height of the point of observation, the latter being 67 feet above tide, while the very foot of the statue, is as we have seen, 176 feet high, and to the ordinary observer within the harbor, owing to the effect of lineal and aerial perspective, aided by the rotundity of the statue in contrast with the square outline of the pedestal, as also the former always relieved against the sky, will still further reduce its apparent diameter; the effect will be to lift the pedestal into undue prominence, and to dwarf the statue by comparison below even what the lineal heights above given in feet and inches would indicate as their respective dimensions. No drawing to scale can possibly illustrate this effect properly. The pedestal in consequence, will always be seen in its full proportions, to which the statue at times, will be but an accessary, and the lines, shadows and relief of the architectural details, of what should be subordinate, will be forced into undeserved prominence. To give the resident of New York a comparative scale by which to measure these heights, I will state, that the vane of Trinity spire at the head of Wall Street, is stated as 264 feet above the pavement of Broadway, which is itself, 50 feet above tide, making the entire height, from water level, 314 feet; the torch of Liberty as designed, is given as 324 feet, or 10 feet higher than the spire of Trinity.

To return to the consideration of the question, as to the principle which should govern in designing a pedestal for a statue in the Greek style of art, such as this. Briefly, it should be simple, severe even, in its outline, without meritricious ornament of any kind, and devoid of obtrusive details, or of any feature which would fritter its mass into an assemblage of parts, devoid of breadth of effect, or from their comparative nearness to the eye, giving them a prominence, wholly unsuited to the subordinate position which they occupy in the composition.

The material should be indicative of durability and strength, and the workmanship, while carefully finished, should avoid any sacrifice of massiveness by the introduction of fanciful or minute surface decorations or lines. But on the contrary, it should appear to be what it really is, subordinate in every way to the statue itself, without a feature to withdraw attention from the noble work of art which it upholds.

If the above appeals to the artistic sense of my readers, as to the requirements in the pedestal for such a statue, as I doubt not it will, what can be said of the design which the people are now called upon to materialize in imperishable granite and which violates each and all of these principles.

In the first place, it is needlessly high for any reasonable command which it gives the statue (supposing the light-house idea set aside). Accepting the line of the terrace as established, (61.8) the height thence to the foot of the statue instead of being 114 feet, can well be reduced materially without loss of effect. As if this 114 feet however were not sufficient of itself to command attention, the accepted design, by breaking the face into distinct features, each with its separate treatment, intended doubtless to relieve the great height but which will have precisely the opposite effect, for the assemblage of parts, however treated, is still but the pedestal, with increased prominence conferred upon it.

Commencing with the plinth 37 feet high, this is sub-divided into two parts; the lowest part of 15 feet high, is not coursed, but stratified, and sustains a sort of frieze with appropriate base and cap mouldings, bearing in relief 40 shields, (10 on each side,) each 10 feet in width, to contain the arms of the several States (though what share they have had as States, or will have, in advancing the monument towards completion is not public,) an elaborate cornice finishes the plinth. Thence the pedestal rises with inclined faces 40 feet more. This is of coursed ashler, the headers in every third course, projecting from the face of the work a foot or more; a simple device, which, without taxing the designer too much, will effectually destroy any *accidental repose*, which would otherwise creep into this part of the structure. There are six rows of these detached blocks, such as are put into high masonry dams to facilitate the renewal of the pointing. This brings us to the loggia, 10 feet above the floor of which an external gallery appears with its projecting parapet, resting on a dentiled cornice, with frieze, the latter supported by 16 fluted consoles, (4 to a side,) each 14 feet high, and 3 feet face, with moulded caps, and resting on a moulded table with corbals under each console; 25 feet above the gallery floor is the level of the foot of the statue. The masonry between is of plain ashlar, forming an upper pedestal, with moulded plinth and cap.

The loggia and the gallery, it will be observed, are designed as outlooks, the latter 151 feet above tide. It is difficult to fix the style of this, further than to characterize it as partaking largely of the modern shop front where the introduction of Greek details by no means constitute a Greek style. The multiplicity of parts is destructure of that repose, which is essential to the effect of any structure which aims to take rank as a work of art.

I would propose, that from the level of terrace (61.8) to erect a pedestal (see sketch on a reduced scale) on the same base as now proposed (64 feet square) of cut granite 72 feet high to the foot of the statue. Of this, 17 feet will be the plinth, perfectly plain, upon which is reared the truncated pyramid, 40 feet on a side at top and 41 feet high, without break of any kind, the remaining 14 feet to the foot of the statue, being occupied by the cornice, which is a simple bead, cavetto, and projecting crown moulding, the entire pedestal being without surface ornament of any kind. Sweep away the granite post fence around the terrace, and substitute a proper metal railing, which will be lost to sight from the shores in either direction, and not mar the elevation by an unsightly farm yard appendage. Abolish the idea of intermediate landings or outer gallery, from which the feeble and infirm can look out upon the landscape, but if there *must* be a lookout short of the level of the torch, floor off a space in the breast of the figure, with openings properly closed, and concealed in the folds of the drapery of the statue.

This proposed change, by taking 42 feet from the height of the pedestal, would lower every point in the statue precisely that amount, thus the crown of the head, instead of 292 feet, would be 250 feet, above tide, and the flame of the torch, instead of 10 feet above, would be 32 feet below the level of the vane of Trinity spire and 10 feet higher than the apex of the towers of the Brooklyn Bridge.

Such a pedestal, would, by its quiet repose, abstract nothing from the grandeur and dignity of the figure above it—this, while seemingly a negative merit in itself, may be regarded as the highest praise, when opposed to the common-place details which struggle into notice in the accepted design.

The suggested modification labors under a disadvantage in its claims to public consideration at this time, and that is in the possibility of its having been induced from a motive of economy merely—as its cost would not exceed more than *one-half* of that at present contemplated. But no such purpose of economy had place in its inception, which was purely in the interest of art, that the component parts of a composition should be in due subordination.

J. W. ADAMS.
Consulting Engineer Department of Public Works.
New York City.

The sketch referred to in the above is unavoidably delayed until our next issue.

Of the $4,000,000 worth of general supplies purchased for the Canadian Pacific Railroad during 1884 only $100,000 worth, or about 2½ per cent, was bought outside of Canada. Including rails, which had to be imported, and all other expenditures in England and the United States, over 93 per cent of the 22,000,000 or 23,000,000 which the company expended in 1884 was paid to the people of Canada.

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IN another part of this issue we give notes of a discussion on Sewer Appurtenances, taken from the report of the meeting of Jan. 13, 1885 of the Connecticut Association of Civil Engineers and Surveyors. The detailed information contained therein is useful and interesting,

MR. GEORGE H. FROST, the senior editor and founder of ENGINEERING NEWS, sailed for Europe on the *City of Chicago*, last Thursday, in company with Mr. Wm. H. Wiley of the publishing house of John Wiley & Sons of this city. Mr. Frost goes abroad partly on business connected with this journal, and partly for the rest well earned by his ardous and long continued services upon the paper which he has built up. While those who remain at the editorial helm will miss him, they, and we trust the many readers of ENGINEERING NEWS, wish him *bon voyage*.

Certain members of the Councils of Philadelphia have been attempting to pass a resolution of censure of the Chief Engineer of their Water Department for telling—the truth.

The offence of Col. Ludlow lay in making an address before the Phila. County Medical Society upon "The Water-supply in relation to Sanitation." In the course of his remarks he told some unpalatable truths about the unsanitary conditions of his own city, and not only pointed out the dangers to be apprehended from a polluted water-supply, impure well-water, lack of proper sewerage and the prevalent evils of house-drainage as too often practiced, but he also intimated pretty broadly that the municipal organization was sadly out of joint that permitted this condition of affairs. He closed his address by stating that "Philadelphia has bitter need of the immediate and stringent application of the laws of sound sanitation," an awkward bit of truth that no resident of, or stranger within, that city can gainsay.

But the publication of these truths was not to the taste of a number of the members of a body which is mainly responsible for this unsavory condition of affairs, and hence the attempt to rebuke an official of the city for telling tales out of school, as they deemed it. The arguments used by these indignant Solons were about as ridiculous as the resolution itself; some of them feared that trade would be injured, were the truth generally known, and prospective investors and buyers frightened off to more healthy parts; in their exceeding anxiety to cover up the evil they gave utterance to a hush! so loud that the matter is now very common property. Others of the councilmen took the ground that it was "presumptious and impertinent" in "their paid servant" to lecture them upon their duties or to presume to talk about city affairs without first submitting his notes to their censorship.

In the first place, concealing the facts will not correct the evil, and continued neglect is certain to bring upon any city the terrible penalty of the outraged laws of sanitation. It is not every municipal official who has the moral courage to give public expression to his true convictions, and in the case in point, Col. Ludlow is to be commended by the people even if he is rebuked by those who insanely imagine that they are the *masters* of the people.

The fact of the matter is that the Councils of the Quaker City have proven themselves very bad *servants* of the people, who have selected them to care for its many needs; otherwise there would be no occasion for the present outcry. A visit to Philadelphia within the week shows it to possess dirtier streets than ever before; and it is with a city as with a boy, if its face is not kept clean the sanitary condition of the more hidden portion of its anatomy are always open to grave suspicion.

It is about time that these Councilmen ceased to "boss," and commenced to serve the interests of the second city in the land; a city proud of its wealth, business activity and general prosperity, yet more than provincial in its cobble-pavements, bad drainage, and sewage-contaminated water-supply. For this publicity is in a measure a corrective, for the pressure of public opinion may finally force the official heads of the community to a more faithful performance of their duty.

Drinking Water at Suakim.

The question of obtaining a sufficient supply of potable water for the pipe line to be laid from Suakim to Berber, has been broached several times in this journal both editorially and by our correspondents. It now seems from the London papers that the evaporation of the water of the Red Sea must be depended upon.

Nearly every vessel chartered for the Soudan expedition has been fitted with special plant for obtaining fresh water by the evaporation of salt water and the condensation of the steam; some of these vessels are fitted with appliances for obtaining 60,000 gallons per day, and have a tankage of 300 tons. The forty-seven condensors, mostly of the corrugated coiled tube patterns, on the twelve ships chartered, have a combined capacity of 268,000 gallons daily.

The Water-supply of the new Public Buildings of Philadelphia.

Howard Murphy, C. E., Hydraulic Engineer of the Commisioners for the erection of the New Public Buildings of Philadelphia, has recently presented a careful and elaborate report upon the water supply proposed for that structure.

Mr. Murphy first considers the probable maximum demand for fire, steam, scrubbing and sanitary purposes, deducing his quantities either from personal experiment or from other like supplies, and finally unhesitatingly recommends provision for a daily supply of one-half million gallons.

Under the "sources of supply" he treats of rain cisterns, driven and artesian wells and water from the city distribution either by gravity or pumpage. His examinations show that the driven-well water is universally contaminated with sewage and is inadequate in quantity. The nearest artesian well to the Public Buildings is at the U. S. Mint; here is an 8 inch well 458 feet deep sunk into gneiss rock, the water rises to within 50 feet of the surface and the yield is stated by the contractor to be 201,600 gallons per 24 hours. Tests by Dr. Thos H. Garrett show 44.829 grains of solid matter to the U. S. gallon, the solids being chiefly sulphates and muriates. This water is reported as unfit for boiler-use though palatable for drinking purposes. The artesian well at the Continental Hotel is 12 and 8 inch bore and is 206 feet deep. This water was at first pronounced pure and wholesome but after ten years use it was contaminated by sewage leaking into the well. A new well, 252 feet deep and 12 and 8 inch bore, has been since put down and yields excellent water, somewhat harder than Schuylkill water. Mr. Murphy estimates that four artesian wells would be required at the Public Buildings, and that at $9.00 per foot for the 12 inch portion and $5.00 per foot for the 8 inch, with an average depth of 500 feet, they would cost $20,900. The cost of lifting this water 50 feet must be added. On account of uncertainty of supply and for other reasons given he does not recommend this method.

In connection with a study of a supply from the city works, a very handsome and complete map is presented showing the routes from the various reservoirs and a diagram of relative elevations of points in the City Hall, the reservoirs and the elevations due to present street pressures. To pump from the street mains near the building would dangerously reduce the already inadequate pressure in that locality, and is only recommended as better than a well supply or as a reserve connection. The Roxsborough and Belmont reservoirs furnish the only available gravity supply; but the first named is nine miles from the City Hall and a main would probably cost $95,000 laid.

The Belmont reservoir has an average super-elevation above the pavement at the City Hall of 159¼ feet and the distance by various routes ranges from 20,300 to 23,300 feet, and in case a special 12 inch main is laid the cost would range from $40,600 to $46,600. Various attachments are possible with existing mains at a decreased total cost, but there are objections in each case. A gravity supply from Belmont reservoir with a reserve connection with the Fairmount main, and a pumping capacity sufficient for an emergency are recommended.

The Corinth Canal.

M. Bazaine, the new Chief Engineer of the Corinth Canal, finding that the method of excavation proposed by his predecessor, and described in ENGINEERING NEWS of June 7, 1884, does not promise rapid progress, has devised another scheme. The original plan for the extraction of the central mass included a series of drill-holes first bored from the top to the bed of the proposed canal (180 feet) and the filling of the holes with sand; these holes were then to be blasted in sections by removing the sand to the depth required, and the face of the work would present a succession of vertical steps each about 50 feet high. The debris was to be thrown into the canal and removed by dredging.

This system of attack has now been changed says *Le Canal de Corinthe* of March 23, by substituting for the high steps mentioned a succession of smaller benches, each 18 feet long by 5 feet rise; this giving a general slope to the working face of somewhat more than 1 to 3. Upon this gradient are located five trough made of steel plate, each trough about 3 fee wide. The loosening of the rock will be accomplished by using many but light charges

of explosive, and the debris will be cast into the troughs and washed down by water pumped from the sea. The material finally falls into the canal as before and is removed by a dredge.

While the later method will require an increased amount of expensive manual labor, M. Bazaine believes the progress will be more certain and rapid. He figures that 260 shovellers could feed into the troughs in 12 hours 4850 cubic yards; and that the total daily advance of the working face would be $9\frac{15}{100}$ feet.

As the dredge must advance daily a distance equal to the above, it will have to take out, in the canal proper, a quantity of 955 cubic yards in addition to the material from above, or about 5,800 cubic yards in all. This quantity does not exceed the capacity of the larger dredges now on hand.

PERSONAL.

ARTHUR POU, of Dublin, Georgia, has been recently appointed Chief Engineer of the Macon & Dublin R. R., with a length of 55 miles. He has just commenced the preliminary survey and the work is to be completed within one year.

SAMUAL BURDICK, C. E., late of the Northern Pacific R. R., has been appointed Chief Engineer of the Ortonville & Lake Superior R. R., the proposed road is to be surveyed immediately.

LANSING MILLIS, president of the Ogdensburg and Lake Champlain Railroad, manager of the Vermont Central, and one of the founders of the National Dispatch Line, died at his home in Millis on April 6. He was one of the best known and most successful of New England railroad men. He was a native of New York.

AT the meeting of the American Society of Civil Engineers on the 8th inst., the following were elected:

FOR MEMBERS: Clifford Buxton, Chief Engineer Ohio Central R. R., Toledo, Ohio; Richard Morley Harrison, Civil Engineer, Liverpool, England; Inspecting Engineer of Iron and Steel manufactured in Europe for the Dominion Bridge Co., of Montreal, Canada; John Franklin Hinckley, Resident Engineer St. Louis and San Francisco Ry., North Springfield, Mo.; Olaf Hoff, Designing Engineer, Shiffler Bridge Works, Pittsburg, Pa.; Edmund Dorman Libby, Resident Engineer, Improvement Mississippi River, St. Louis, Mo.; Robert Henry Temple, Civil Engineer, Richmond, Va.; recently Chief Engineer, Richmond and Alleghany R. R., and Chief Engineer, Georgia Pacific R. R.; Theodore Voorhees, Superintendent Saratoga Division, Northern R. R. Dep't Delaware and Hudson Canal Co., Ballston Spa, N. Y.

FOR JUNIOR: David Coley Sanford, First Assistant Engineer, Connecticut Shell Fishery Commission, New Haven, Conn.

COL. JAMES WORRALL, a prominent Civil Engineer of Pennsylvania, died at his residence in Harrisburgh, Pa., onApril 1, aged 73 years. Mr. Worrall was born Jan. 12, 1812, in the city of Limerick, Ireland. His father, John Worrall, merchant, having failed in business, came to America, and having first tried again the mercantile business, finally became a teacher in a ladies' boarding school. He died in 1845.

James Worrall, after an apprenticeship with Carey, Lea & Co., of Philadelphia, at the age of 19 years secured a position under F. W. Rawle on an engineer corps, on a railroad in Northumberland Co., running from Shamokin, to the Susquehanna and West. This road surveyed in 1831, was built in 1882, fifty years afterwards. In 1832 he was on a railroad survey in North Carolina, and in 1833, under Judge Benj. Wright, he was engaged on the Erie Canal. He then joined Mr. Thos. F. Penall's corps on the Chesapeake and Ohio Canal, and remained there until 1835, when he assisted Col, Schlatter in surveying a railroad line from Trenton to New Brunswick, N. J.; after that he was on the James River and Kanawha with his old master, Judge Wright, and with Chas. Eliet, Jr.

In 1838 he was engaged with Hoger Hage in making a survey through Pennsylvania from the Cumberland Valley to Pittsburg, on a line now partly occupied by the South Penna. R. R. He was next principal assistant to Milnor Roberts on the Erie extension of the Penna. Canals. In 1844 he became connected with the firm of Chamberlain & Co., and as contractor built a large portion of the St. Lawrence Canals and the Rutland & Burlington, and the Ogdensburg & Rouse's Point railroads.

In 1850 Mr. Worrald returned to his profession, and subsequently became Chief Engineer of the Union Canal of Penna., running from Middletown to Reading; this work which had previously been a failure, was made a profitable financial investment under the able engineering of Col. Worrall. On the completion of the enlargement of this canal, Col. Worrall became Principal Engineer on the Western division of the Phila. & Erie R. R., the consulting engineer being Mr. Robert Faries. In 1860 he returned to Harrisburg, and again became interested in the South Penna. railroad line; he surveyed a connection between Harrisburg and the Hother Hage route of 1838 by way of the Sherman Valley and investigated other lines, and on the organization of a company was elected its president, and so remained for twenty years until it was bought out and merged into the present South Penna. R. R. Co., now under construction.

After 1860, Col. Worrall acted as clerk in the Quartermaster's department, his age preventing more active military service. In 1866, at the call of Sir Morton Peto, he recommended an extension of the Catawissa system, across the State of Pennsylvania to the Ohio River, associating with him Col. Milnor Roberts, Col. Jarrett, Major Wm. F. Shunk and others. In 1867 he was engaged in projecting a canal on the Rock River in Illinois and Wisconsin, and in 1868 in similar work on the Illinois River. Since 1869 Col. Worrall has acted as Fish Commissioner for the State of Pennsylvania, and as actuary of the State Board. In this connection he made other important canal surveys.

MR. HENRY M. WIGHTMAN, M. Am. Soc.C. E., City Engineer of Boston, died at his residence on Friday the third inst., from an attack of pneumonia contracted on a recent visit to North Carolina. Mr. Wightman was a son of the late Hon. J. M. Wightman Ex-Mayor of Boston, and his entire professional experience has been in connection with the public works of that city.

In 1858, at the age of 18, he entered the office of James Slade then City Engineer, and until 1866 was employed in that office in various positions. In 1866 he was appointed resident engineer at the Chestnut Hill Reservoir, and during the next four years he was in charge of the construction of this important work.

On its completion he became Assistant City Engineer, and held that position during the the construction of the works for an additional supply of water from the Sudbury River and until the resignation of Mr. J. P. Davis, the City Engineer in 1880. Mr. Wightman was then elected to succeed Mr. Davis, and he has been City Engineer since that time. During his term of office the greater portion of the New Main Drainage Works, which had been commenced under Mr. Davis, has been constructed; a large storage reservoir has been built on the Sudbury River, and a very large amount of engineering work has been done in connection with the system of parks now being built in Boston.

As City Engineer, Mr. Wightman had charge of all engineering work in connection with the improved sewerage, parks, water-works and bridges. He was one of the most valuable officials in the employ of the city, and his place will not be easily filled. Resolutions of condolence were passed by the joint standing committee of councils on water, by the Water Board and by the Committees on Civil Engineering and Sewerage.

Weights on Crowded Floors.

In the course of the discussion at the Institution of Civil Engineers of a paper on "The Construction of Charing Cross Bridge," Mr. E. A. Cowper said he had tried the weight of a number of laborers, by weighing each man individually, and then by measuring the exact space they occupied when standing close together, as in a crowd, when he found their collective weight was fully 140 pounds per square foot. He was, however, aware that from 60 pounds to 80 pounds was often taken as a test load, but that was far below the weight of a crowd of able-bodied men. Mr. Mallet remarked that, during the building of Buckingham Palace, Mr. Nash ascertained the greatest possible load of human beings that could be brought upon a given space, with reference to the so-called fireproof floors of the palace. Within a hoop, he thought of about 20 feet diameter, as many men were caused to stand as could be wedged into it, the last men being lowered down amongst the others. The result gave a load of 120 pounds per square foot. Mr. Hayter stated that 70 pounds per square foot was probably the maximum living load that could be crowded on a given space. Messrs. Cochrane & Co., had tried an experiment, selecting for it the tallest and most muscular men in their establishment, and the result proved that the estimate of 70 pounds, was ample. Sir John Hawkshaw said he had been found fault with for assuming so much as 80 pounds per square foot as the weight of a crowd of human beings. French Engineers and others were said to be content with 50 pounds to 60 pounds per square foot, but he was satisfied with 80 pounds per square foot.

American Society of Civil Engineers.

MARCH 18TH, 1885.—Vice-President G. S. Greene, Jr., in the chair. A paper by Mr. D. J. Whittemore, past President Am. Soc. C. E., on Roofing-Slate was read. The writer used, in 1872, a large amount of Pennsylvania black slate for roofing some freight houses in Chicago. The slate seemed to be of fair quality; but in about six years thereafter disintegration occurred to such an extent that it became necessary to remove nearly the whole of it.

In 1879 there was required a large amount of slate for shop buildings for the Chicago, Milwaukee and St. Paul Railway, and proposals were received from a number of firms for its supply. Seventeen varieties from as many different quarries were received, and in order to judge of their quality, experiments were made as to the comparitive strength when submitted to transverse stress, as to the relative avidity for water as shown by capiliary attraction, as to the relative specific gravity, and as to the relative absorption of water when immersed. Two slates of each variety were given to one assistant, and two to another, for the purpose of testing, and they were directed to give for each slate a distinctive number in a scale of seventeen parts. Both assistants agreed in their determinations as to the position of each slate with reference to this scale. The assistants were not acquainted with the price of any of the slate. From the determinations thus made a table was formed by the writer, giving in separate columns the figures determined, and in another column

the figures showing the cost of each variety, and an addition of these figures was considered as fairly showing the relative positions of the different varieties.

The slate offered at the lowest price gave the best aggregate, and was purchased. It was a green slate from Vermont, and has been used upon a large number of buildings, some of which have been in service over five years, and no complaint as to quality has been made. The writer is not prepared to say that the deductions thus made can be in all respects considered a fair relative exponent of quality, but in this instance the decision is apparently justified by experience.

A paper by Mr. William P. Shinn, M. Am. Soc. C. E., was then read in reply to a paper by Edmund Yardley, M. Am. Soc. C. E., in discussion of Mr. Shinn's previous paper on Railway Efficiency. Mr. Yardley suggested that the average movement of cars on foreign roads has, contrary to Mr. Shinn's supposition, increased since 1868, and not diminished. To this Mr. Shinn presents the statement—also prepared by Mr. Yardley—showing that the mileage of cars absent from the Pittsburg, Fort Wayne and Chicago Railroad has increased as stated; yet that, as this company is leased to the Pennsylvania Railroad, it is scarcely fair to include the Pennsylvania as a foreign road, and deducting the cars counted as absent which were upon the Pennsylvania Railroad, the movement on actual foreign roads is diminished and not increased.

Mr. Yardley does not consider that there is any necessity for the new system of blanks proposed in Mr. Shinn's previous paper; to which it is replied that, by the use of that system the change can be accomplished, and the per diem plan put into operation, without any addition to the expense at present incurred in keeping trace of cars, provided that the charge for cars is made sufficiently high to operate as a penalty for their detention.

Mr. Yardley criticized the rate proposed: in answer to which Mr. Shinn referred to his paper published in the Transactions for June, 1883, page 215, where he suggests at the rate five cents per ton per day, reckoned on the capacity as marked on the cars. This method is important on account of the many and widely and different tonnage capacities—cars running from five to thirty or thirty-five tons. The suggestion of furnishing cars upon the basis of the annual cost of repairs plus the interest on the cost, divided by the number of working days in the year in order to reach a per diem rate, is lacking in equity.

A letter was quoted, illustrating a marked case of increase in the efficiency of railroads to transport freight occurring in Holyoke, Mass.

Mr. Shinn suggested that if the car accountants of the country would apply the experience which they had to the consideration of the facts in their possession and within their reach there would result an early action. The fact that, during the past year of dulness in all traffic, many railroad companies increased their car equipment in the face of the wholly inadequate movement of cars, needs explanation, and the policy which led to the increase needs correction.

JOHN BOGART.
Secretary.

Proceedings of the Engineer's Club of St. Louis.

The Club was called to order April 1, at 8 P. M. by Vice-President McMath; thirty members and four visitors being present.

Minutes of last meeting were read and approved.

Executive Committee reported that the resignation of Mr. E. Harrison and Mr. Samuel Rockwell had been accepted; also, that C. D. Lamb and J. C. Meredith had forfeited their right to membership by non-payment of initiation fee.

The amendment of Sec. 7, of the by-laws, proposed at the last meeting was adopted by a unanimous vote.

The following gentlemen were proposed for membership: Mr. O. A. Orrman, St. Louis, Mo., by Messrs. J. A. Ockerson and C. W. Clark; Mr. Walter S. Russel, Detroit Mich., by Messrs. W. B. Potter and I. A. Ockerson.

Prof. F. E. Nipher read a paper on "The Efficiency of a pair of Holtz Machines, one acting as generator and the other as motor," which was discussed.

Mr. K. Tully read a paper on "Construction in Wood and Iron."

THOS. D. MILLER, *Sec'y.*

Engineers' Club of Philadelphia.

RECORD OF REGULAR MEETING, MARCH 21, 1885.

President J. J. de Kinder in the chair; 32 members and 7 visitors present.

Mr. E. S. Hutchinson proved geometrically that the well-known Latitude and Departure Method of Calculating Areas was true for all positions of the assumed axis or meridian, provided due regard be had to the signs; from which it was obvious that tedious computations could always be very much shortened by conceiving the meridian to pass through a convenient point *within* the area, instead of through the *most easterly or westerly* point, as given in the books.

Mr. John Wood, Jr., visitor, exhibited handsome working models of cars and tracks equipped with the Curtis & Wood Automatic Car Coupler, and explained its workings. Various tests of the model were proposed and successfully made.

The Secretary presented, by title, for Prof. L. M. Haupt, a revision of his paper upon Scales of Maps, which Prof. Haupt has prepared for the Club Reference Book.

The discussion on strengthening the West Main Abutment of Chestnut Street Bridge was continued by the author of the paper, Mr. J. Milton Titlow, and others.

Mr. Titlow said:

"In answer to Prof. Haupt's criticisms that 'he felt disappointed that the paper did not contain some data, which would support the theory which led to the use of the piles in their present position:'

I did not consider it necessary to enter into more details than were given; but will now say that longitudinal measures taken on the roadway from Twenty-fourth to Thirtieth Streets, allowing for inaccuracies in measuring, show in the last ten years, a shortening of the distance between the east main abutment and the west approach abutment, being greatest over the brick arches.

Range lines during the last six years have been established to measure positively the movement of the west main abutment, which, by reason of the changes that have taken place on the properties adjoining the bridge, are not now available. That from the apparent condition of the structure, it was positively inadmissible to wait for subsequent changes or movements.

He also says, 'If the damage to the west abutment was caused by the *thrust of the iron arches*, as alleged, then its effect would be first manifested on the abutment pier and the adjoining brick arch, before reaching the extreme or land side of the second masonry arch.'

It would be most clearly manifested where the parts are so disposed and of sufficient bulk to offer the most effectual resistance; that is, at the ends of the small abutment, by it being buttressed by the retaining walls, causing chipping, etc., where, the joints are fine and close; also the shortening of that part of the span, and a rising of that part of the adjoining arch opposite them.

Between the retaining walls, where less resistance was offered, and the abutment weaker than the arch, it was pushed back; the span at the point of greatest movement not being similarly shortened, and *the shape* of that part of the adjoining arch remaining approximately as originally constructed, the soffit being now lower at the north and south faces.

The small pier between the approach spans, not being capable of sufficient resistance, the top moved westward somewhat with the 60 feet span, and consequently this arch was the last to show the change.

He believes 'that the defects of the bridge resulted from a slight settlement or springing of the piles under the corners of the foundation of the abutment and approach walls, thus reducing the frictional resistance of the masonry on the grillage, and permitting the excessive pressure of the earth filling, especially when saturated with water, to overcome the inertia of the masonry in these walls, and break the bond, which, in some places, was very weak, causing the large cracks in the approaches and the first arch.'

There has not been any independent settling of the ends of the small abutment, that can be detected. The breaking of the bond or pulling apart of the vertical joints forming the crack, has been caused by a transverse force, the result of the horizontal thrust going in a somewhat diagonal direction to the retaining walls together with an outward movement of the top of the north wall.

From my knowledge of the condition of the filling behind the small abutment, it is not saturated with water above the general surrounding surface, and that this pressure is not the principle cause of the failure of that abutment.

In answer to Mr. Howard Murphy that the horizontal wooden struts under the arches: 'If tight, they afforded a very convenient rigid medium for the transmission to the bridge foundations of every shock and hammer blow incident to heavy railroad traffic:'

They were intended only as a temporary expedient and the only thing that could be quickly applied to answer the purpose. They were designed and built before the railroad that now passes over them, although it was at that time located; and the solid platform was placed under them to prevent their depression and vibration as much as possible.

They may be cut off, after the concrete in the buttresses has thoroughly hardened.

Mr. C. G. Darrach says: 'A very decided crack or break in the retaining wall on the south has developed next to the buttress. This crack runs from 0 under the coping to 5 inches in width at a level with the spring line of the arch, and is nearly parallel with the face of the end of the abutment, *showing clearly that the masonry has been forced eastwardly*:'

This opening above the surface of the ground is not a crack, being only a joint in the masonry out of which have fallen the small stones and mortar, probably by the action of the weather, and has not been mentioned, because it does not indicate an eastward or longitudinal movement, not showing below the surface for two feet, as far as examined.

It does not appear in any form on the north retaining wall.

I believe all the other points are to be found in the paper itself.'

Prof. L. M. Haupt called attention to a communication from Mr. S. Haslett in the *Railroad Gazette* of February 20, 1885, supporting his view that the defect of the bridge was in the west abutment and due to the weight of the filling and defective foundation. He also read a communication from himself to the Editor of the ENGINEERING NEWS of March 11th, 1885, to the same effect.

Mr. Howard Murphy, in reply to Mr. Titlow as to the wooden struts, still maintained that even *temporary relief* is not likely to be afforded to failing masonry by placing its foundations directly under the influence of the heavy yard traffic of the Pennsylvania Railroad, at the foot of a heavy grade.

Mr. Rudolph Herring said:—

"I am somewhat at a disadvantage in discussing Mr. Titlows's paper, as I was unfortunately absent when it was read. Nor have I as yet read the other discussion on the matter. As I had occasion, some years ago, to make a number of measurements at the bridge, and formed then my own conclusions regarding its movements, I will state my views without reference to Mr. Titlow's paper. These views I expressed informally after a meeting at the Club in 1880.

To rightly understand the present condition of the bridge, it is necessary to discuss certain of its features independently of each other, as, I think, the trouble results from several independent causes.

First.—The steps that have recently been taken to secure the stability of the bridge, are based on the supposition that the western abutment pier is moving westward. I do not think that this supposition is sufficiently substantiated by the facts, although certain appearances would lead one to infer that it was. The spaces left for the expansion of the iron cornice measured on a very hot summer day about ¾ inch on the east, and a little over 1 inch on the west river arch, showing therefore that if there had been actual contract at such a time, when the bridge was built, the extreme movement since then could not have been over the sum of these figures, or 2 inches. Moreover a westward movement of 2 inches in the abutment, would have supposed the pier also to move, namely ¾ inch; or, should the pier have remained stable, the west abutment could have moved only 1 inch, all supposing that the iron and stone work movement of the abutment pier would have affected the first brick arch by raising it, and, in this way, exhausted its force. It could not have extended over the arch, and moved the small pier beyond, much less the second arch, which is the one most distorted. It must be remembered that the line of thrust from the river span, down into the abutment pier, strikes inside of the platform, and I believe also inside the footing of the piles. From these facts, I think, it can readily be concluded that there has probably been no motion of the western abutment, and positively not over 2 inches, an amount insufficient to explain the buckling of the brick arches.

Second.—Marks were made every 50 feet on the curb-stones, beginning at the west house line of 23d Street. A re-measurement of these marks showed a lengthening of the distance on the west slope of the bridge, indicating unmistakably a westward movement of the curbs. This led, at first, to the supposition that the west abutment was moving, but from the fact that a slight *shortening* of the distances occurred on the east slope of the bridge, I think the change of position in the curbs is to be attributed to a down-hill crawling, similar to that of track on a down grade.

Third.—That the steep grade of the western approach of the bridge, being over 4 feet to 100, has an effect upon the form of the brick arches, I think there can be no doubt. A bridge in Switzerland, consisting of a series of arches, with a surface on a grade of over 5 to 100, was described in a European publication, some years ago, as having required extensive repairs due to the deformation of the arches, caused by the unequal loading of the haunches on account of the steep grade. This deformation consisted in the flattening of the arches on the up-hill side and a corresponding pushing up on the down-hill side. The two brick arches on the western approach of Chestnut Street Bridge show the same deformation, the up-hill side of the arch being flattened. In fact, the same thing is noticeable in the arches on the *east* side of the bridge; but it is not as great, owing, no doubt, to the fact that the grade there is less.

Fourth.—The westernmost brick arch is buckled considerably more than any of the others. This is caused mainly by another feature of the bridge, and, I think, the most serious one. The west abutment and a portion of the approach are built on the site of an old canal or slip. The ground consisted mostly of fine mud. The abutment and retaining walls were built upon piles capped with timber platforms. Soon after the filling was put in behind the walls, a considerable bulging out occurred caused by the weight of the earth filled in, pressing down and out into the soft mud into which the piles were driven. This was so great on the south side, that it was necessary to drive additional piles and build the wide buttress now existing about 50 feet back of the abutment. At the same time, the platforms under the retaining walls, was pushed out towards the river. There seems to have been little, if any, movement in this abutment since that time. About six years ago, it was feared that the retaining walls over the old slip were bulging, judging from the settlement of the roadway, and about half-a-dozen 2½ inch or 3 inch iron tie-rods were put through the walls near the top of the ground, and fastened with heavy timbers, thus effectually guarding against any further bulging at that place. Nothing has been done to the west abutment since its first movement. The present position of the butresses on the north and south sides, shows that the foot of said abutment, at the corners, has moved out about 5 inches. On the south side, the opening caused by this movement shows itself as one crack, from nothing near the top to about 6 inches near the bottom. On the north side, the opening is divided among a number of joints in the rough rubble masonry. The face of the west abutment is concave, the concavity measuring about 5 inches at the springing line, and probably nothing at the platform.

The reason why the face has this peculiar surface, can be explained as follows:—The butresses on each side, being built of cut stone masonry well bonded with the abutment, give the ends of the latter such a rigidity that, when the foot was pushed out, it carried the skew-back of the arch, and therefore the arch itself, with it; both butresses remaining perfectly straight, although out of plumb. The center of the abutment did not move out correspondingly, because of the relatively greater resistance of the arch, on account of the wall in the center not having the strengthening benefit of the cut-stone face work and buttresses, and also being of much less thickness at that place, a fact not indicated on the plans. The centre of the abutment was even further weakened by a crack from the arch down to below the surface of the ground.

This moving out of the west abutment, as indicated above, necessarily pushed the ring-stones and the adjoining brick arch *eastward*, and this movement, in addition to the other cause already mentioned, explains the much greater raising and cracking at that particular arch.

To recapitulate—It seems to me:—

First.—That the abutment pier which has recently been braced by concrete cylinders, has moved very slightly, if at all, being the only part of the bridge on the west side of the river, which is plumb, which has not settled and shows no cracks.

Second.—That the horizontal timber struts put in under the brick arches, if they show, at present, any compression at all, are compressed rather by an *eastward* movement of the west abutment, than by a *westward* movement of the abutment pier.

Third.—That the deformation of the brick arches is partly accounted for by an unequal loading of the haunches, due to the heavy grade of the bridge.

Fourth.—That the greater deformation of the westernmost arch, is caused by the eastward movement of the west abutment, which appears to be the main cause of trouble, but for which avowedly no remedy has as yet been applied."

HOWARD MURPHY,
Secretary and Treasurer.

CORRESPONDENCE.

Oil Well Machinery.

MCKEESPORT, PA., March 31, 1885.

EDITOR ENGINEERING NEWS:—Relative to the enquiry of Mr. Dunn, the following may be of service in answer to question 3. Vol. III. of the Second Geol. Survey of Penna. contains a full account of oil well rigs, drawings of tools, etc., together with the mode of operating and much valuable information relative to the subject of oil wells generally.

Yours truly,
H. A. BOYD.

Contracting Prices in Japan.

TOKIO, JAPAN, March 10, 1885.

EDITOR OF ENGINEERING NEWS.—According to promise I send you a Tokio price list. It has been prepared with some difficulty by my assistant, Mr. Yeiji Nakajima, for the use of the engineering classes in the University of Tokio. It will probably be of interest to some of your readers, for I am often asked questions by American engineers concerning contracting in Japan. One hundred sen make one yen or Japanese paper dollar, the value of which is fluctuating. The last quotation was one Mexican dollar = 1.31 yen. The value of the Mexican dollar is also fluctuating. At present it is very low, only 85 cents in American gold, making the value of a paper yen about 70 cents gold.

Granite	58 to 68 sen per cu. ft.
Bricks (polished)	9.60 yen per M.
" (plain)	6.70 to 7.30 yen " "
Tiles (polished)	4.10 yen per hundred
" (common)	1.90 to 2.35 yen " "
Lime	7.00 yen per ton (2,000 lbs.)
Cement	3.60 to 4.80 per box (370 lbs.)
Sand	15 sen per cu. yd.
Gravel (pit)	47 " " " "
" (river)	54 " " " "
Wrt. iron (bar)	3 sen per lb.
" " (rod)	3½ " " "
Cast iron (poor quality)	2 to 3 sen " "
Lead	4 to 5 " " "
Copper	20½ to 22½ sen per lb.
Brass	20 to 24¾ " " "

TIMBER.

Criptomeria Japonica	10.40 to 14.60 yen per M. B. M.
Pine	14.60 to 17.40 " " " "
Thuya Obtusa	25.70 to 43.80 " " " "
Zelkowa Keaki	38.60 to 57.60 " " " "
Red Pine	13.90 to 23.10 " " " "
Thuya Pisifera	17.40 to 27.80 " " " "
Tsuga Se boldii	31.30 to 38.60 " " " "
Abies Firma	10.00 to 13.90 " " " "
Oak	30.90 to 38.50 " " " "
Chestnut	17.40 to 23.10 " " " "
Cercidiphyllum Japonica	15.30 to 23.10 " " " "
Magnolia Hypolenca	15.30 to 23.10 " " " "
Cinnamonum Camphora	17.40 to 24.80 " " " "
Cherry	17.40 to 23.10 " " " "

WAGES.

Hewer	25 sen. per day.
Sawyer	50 " "
Carpenter	50 to 55 "
Mason	65 to 70 "
House Painter	52 to 55 "
Tilelayer	45 to 50 "
Bricklayer	62 to 65 "
Blacksmith	60 to 70 "
Painter	50 to 55 "
Laborer	30 to 35 "
Paper-hanger	55 to 60 "

The list is not as complete as we hope to make it.

I have been asked on several occasions what chance there is for a foreigner to do contract work in Japan. At present there is none whatsoever; but the treaty with foreign powers is now undergoing revision, so it is probable that ere many months foreigners will not only be allowed to travel without passports anywhere in the empire, but will be permitted to do business.

There ought then to be an opening for American capital, and the profits ought to be large, especially at first; for labor is decidedly cheap. On the other hand the amount of work done per man per day is generally small; but, in my opinion, with proper inducements and good management, Japanese laborers may be made to do as much work in a day as do three of any other nation. Although small in stature, they, by years of training, learn to carry and drag loads and run distances, which to foreigners seem enormous.

I have often seen carts in the city of Tokio containing loads of at least one thousand pounds, each pulled by one man. When the grades are light they manage to ascend by angling across, but when they are heavy it is necessary to have two or more men to a cart.

Loads are often carried on the ends of a pole, which is balanced on one shoulder. An athletic foreigner once told me that he saw a little fellow not five feet high, carry to the top of a mound in this manner two stones so heavy that neither he nor any of the other foreigners who were with him, although powerful men, could raise from the ground. The same gentleman was once pulled in a jinrikisha up hill and down in one day by one man sixty-five miles. When the roads in the

country are good, the rate of travel by jinrikisha is five miles per hour, including stoppages—almost as fast as by stage. But there is this difference; horses are changed every ten miles, but the men run steadily all day. The native horses are miserable half-starved brutes, and are so expensive to keep that their labor is seldom employed in engineering work.

The methods of working are very crude: for instance, earth is carried on a straw mat hung from a pole, which rests on the shoulders of two men.

As the Japanese are very quick at learning foreign ways, there should be no trouble in teaching the laborers the use of American implements.

Yours respectfully,

J. A. L. WADDELL.

Grade for Side Tracks.

WASHINGTON, D. C., March 31, 1885.

EDITOR ENGINEERING NEWS:—In your issue of March 28th., Messrs. Fisher and Brereton have taken exceptions to my use of the formula for determining the accelerating force of gravity on a grade: viz:

$$\frac{\text{"}V}{5280}\times 2000\text{"}$$

or $W \times$ *tan. of angle of inclination*, the "$W \times$ *tan. of angle of inclination*" being supplied by them.

For their benefit I will quote from a few well known authors on the subject. Field Engineering. Searles. Pages 27 and 28. "The second resistance considered is that due to gravity in grades.

Let G = rise of grade in feet per mile.

Let q = resistance in pounds per ton due to grade.

$$q = 2240\frac{G}{5280}$$

Economic Theory of the Location of Railways—Wellington. Page 53.

"The accelerating force of gravity is given by the formula

$$\frac{\text{rate of grade per mile}}{5280}\times 2000\text{"}$$

Manual for Railroad Engineers. Vose. Page 34.

"The resistance due to a grade of any inclination is found by the simple mechanical rule of multiplying the load by height, and dividing the product by the length of the incline. Thus the resistance per ton due to a 24 feet grade is

$$2240 \times \frac{24}{5280} = 10.2 \text{ lbs."}$$

The first and last of the formulae being given for the long ton of 2240 lbs.

What chagrin these well known engineers must feel when they learn that they have all their lives been using "tan. of angle of inclination" instead of "sin of angle of inclination.

In regard to quoting the above expression with a resistance of 4½ pounds per ton, what I said in my article of March 14th was "V = 11.88 feet, which is the grade on which a train in first class order ought to just *stand*, but would continue in motion if once started."

In printing the word stand was changed to start. Being immediately followed by the clause "but would continue in motion if once started," I did not suppose any intelligent reader would be misled, and therefore did not ask you to make any correction.

In determining what load an engine could haul it would not be well to take the resistance as low as 4½ pounds per ton, but for a side track in a principal street of an important city it would be proper to take the lowest possible value, for the grade ought to be such that a car in motion would come to rest within a reasonable distance.

There is no doubt but many freight cars will stand on a grade of 0.6 feet per 100, but the experiments of Benj. H. Lathrobe on the Baltimore and Ohio Railroad and Zerah Colburn on the Erie have abundantly shown that at speeds of from 1½ to 3 miles per hour the resistance may be as low as 4½ pounds per ton.

FRANK C. DAVIS.

Nashville Water Works.

EDITOR ENGINEERING NEWS.—An item concerning the new Water System of Nashville under "Water," in your issue of March 28th has several errors which I beg leave to correct by giving you the facts as they stand. You incorrectly place me as City Engineer. Captain Edward Meade is efficiently performing the duties of that office. My connection with the city improvements is purely temporary holding an engagement as Hydraulic Engineer simply during the construction of the new water-works.

After a careful examination of the question of water-supply I recommended in December last the selection of the Cumberland river as the source of supply, the Pumping Station to be placed about two miles above the city and just above the mouth of a very impure stream. The points farther recommended by me were:

1—The changing of the channel of this stream so as to enter the river lower down and below the lower end of a long narrow island opposite its present mouth.

2—The construction of an Intake Crib in the river at the upper end of the island, opposite the site of the proposed pumping station.

3—The construction of a receiving and distributing reservoir in the city.

There had already existed in this island an infiltration gallery formerly intended to be the source of intake for the present works. This has been lying idle for several years and in fact never has been used excepting during a test of about twenty days' duration, which indicated that the necessary size for a gallery to give the required amount for the city present supply should be about 1,500 feet. Bills have passed the city council for the execution of the points proposed except the construction of the reservoir and in *addition*, a bill providing for the taking of water from the island filter increased to the indicated size. The intake crib will also be constructed as a reserve in the event of the failure of the island filter. The force main from the pumping station will connect directly with the street distribution system. The new Holly-Gaskell engine of ten million gallons capacity is now ready for its foundations.

OLIN H. LANDRETH.

School of Engineering,
Vanderbilt University, April 1st, 1885.

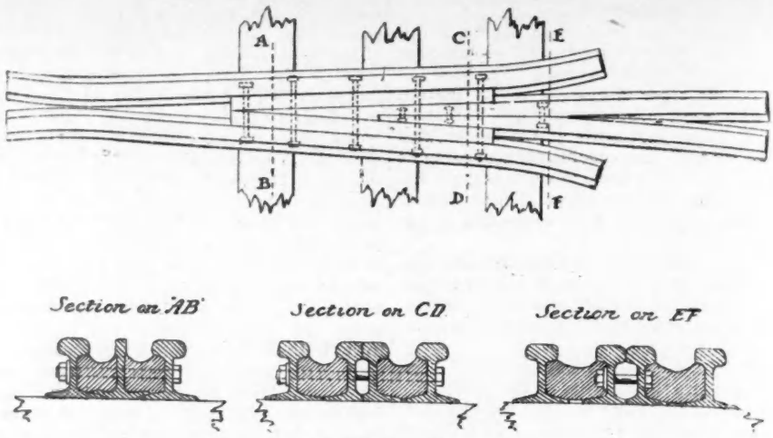

FIG. 77. BOLTED FROG.

TRACK.*

BY W. B. PARSONS, JR., C. E.
ROADMASTER SUSQUEHANNA DIVISION ERIE R. R.

(*Continued from page 220*).

All rivet holes should be carefully drilled according to template, so that the sides of the tongue will line exactly with the rails beyond the throat. The total length of the frog should at least be great enough so as to permit angle plates to be used in connecting it with the track, for a long frog well secured rides better than a short one, which quality materially prolongs its life. The general dimensions as given in Fig. 75, are recommended. In placing a plate frog in the track it is not necessary to cut the ties down the thickness of the plate although it is commonly done, better let the weight spring the ties half the distance and the jar is sure to settle the frog ¼ inch, and frogs must always be tamped high to meet this settling. The ties under a plate frog should be placed as indicated in the figure. "Hollow" tires bear on the wing rails opposite the point, and here it is that all frogs wear first, and when a riveted frog breaks it is usually at this place. A hollow tired wheel is one where the tread at the part where it is usually in contact with the rail has been worn down so that the outer rim projects in the same manner as the flange on the other side. Fig. 76, shows a hollow tire and a sharp flange both the result of wear, the dotted line representing the original surface. In passing over a wing rail of a frog it is evident how such a wheel is carried entirely by the outer rim. If it were not for such wheels the life of a frog would be as long as that of a rail, therefore it is important to watch all wheels and remove them as soon as the tread becomes too much worn.

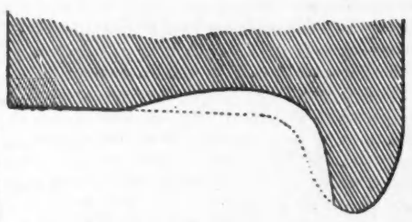

FIG. 76. SECTION OF WORN WHEEL TREAD.

In order to present a frog lighter, with the same elasticity as an ordinary rail, resting directly on the ties, and permitting the worn-out portions to be replaced in the track the bolted frog was invented, whose details of construction vary slightly with different makers, but of which Fig. 77 is a good sample. The tongue and wing rails are made in the same manner as those of a riveted frog, but are held together by long bolts passing through the webs and are separated by cast-iron "fillers." All the above claimed advantages are certainly gained, but are more than balanced by the accompanying disadvantages of this pattern. The bolts will work loose and need constant watching. That side which is exposed to the greatest traffic cuts down into the ties so that the surface of the frog is warped, and then the fillers of cast-iron break. When these break the tongue generally breaks at the dove tail joint and then the frog is decidedly unsafe. In warm weather when the joints back of the frog were tight I have seen all the bolts sheered off by the pressure due to the expansion of the rails. As with the plate frog it is recommended to put a tie under the point.

(TO BE CONTINUED.)

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NEW STEEL SLEEPERS.—The North Eastern Railway Company have arranged to lay three-quarters of a mile of the main line north of Ferryhill, Durham Co., with a new kind of steel sleeper. The sleepers are the same length as the old wooden ones now in use., viz. 9ft. They are 9in. wide and weigh 2 cwt., and are fitted to a cushioned steel chair, the same being fixed by six small rivets. Should they be found to answer, it is the intention of the railway company to lay the whole division with them. It has been found that the ordinary steel rails now in use will fit the chairs, even after being worn and flattened.

IN Southern Russia, self-raking reapers of both American and English make, are used to a considerable extent. The American reapers have the preference, and are driving the English out of the field.

Gibb's Cement.

When Mr. John C. Trautwine stated in his Engineers Pocketbook that many spurious and inferior articles are sold under the name of Portland Cement, he was hinting to the profession and to cement buyers the necessity for testing for quality, and this is now very necessary when so many different makes are put upon the American market. Mr. Fleming, who has made a study of Portland Cement and tested by analysis in addition to the usual methods, imports several brands from England and the Continent to suit buyers, and is particularly fortunate in his selection of Gibbs Cement, as this celebrated brand is endorsed by leading Engineers, etc.

Amongst other important contracts it has recently been supplied for: East London Harbor (under Sir J. Coode) 5,000 tons; Metropolitan Board of Works (under John Grant, Esq.) 6,000 tons; Liverpool Docks (under G. F. Lyster, Esq.) 50,000 tons; New Haven Harbor (under F. Bannister, Esq.) 10,000 tons; Quebec & Esquimault Docks (under Messrs. Kinipple & Morris) 5,000 tons; The Tay Bridge (under Messrs. Barlow & Son) 4,000 tons; Barrow Docks (under F. C. Stileman, Esq.) 7,000 tons; Dublin Port & Harbor Board (under B. B. Stoney, Esq.) 5,000 tons; Dublin Corporation Works (under Parke Neville, Esq.) 1,000 tons; Cork Harbor Board (under P. Barry, esq.) 2,500 tons; Alexandria Docks, Hull (under Jas. Abernethy, Esq.) 4.000 tons; Victoria Dock, London (under A. M. Rendal, Esq.) 4,000 tons.

A paper read before the American Society of Civil Engineers by J. Vincent Browne, C. E., relating to the extraordinary results obtained from the use of Gibbs Cement in the Quebec Harbor Improvement Works provoked a discussion and Mr. Howard Fleming, 23 Liberty Street, New York, will be pleased to give further information about it.—(AD.)

The Theory and Calculation of Earthwork Slopes.*

Written for ENGINEERING NEWS.

BY MANSFIELD MERRIMAN, M. AM. SOC. C. E.
Prof. of Civil Engineering at Lehigh University.

Continued from Page 221.

8. LIMITING DEPTHS AND SLOPES.—Formula (11) furnishes the means of finding the maximum depth h of an excavation for a given slope ϕ or of finding the maximum slope ϕ for a given depth h. In both cases the angle of repose φ and the vertical rupturing depth H are to be found by experiments on the material as explained in Arts 3 and 6. When ϕ is given the value of h is

$$h = H\frac{(1-\sin\varphi)\sin\phi}{1-\cos(\phi-\varphi)} \qquad (12)$$

and this is the depth for which rupture will occur.

For example let it be required to find the maximum depth of a cut when the slope ϕ is to be made 45°, the value of H being 6 feet and that of φ being 30°. Here

$$h = 6\frac{(1-0.5)\,0.707}{1-0.966} = 62 \text{ feet.}$$

For stability the depth must of course be less than 62 feet, and precautions be taken that the cohesion of the earth be not destroyed by the action of the weather.

When h is given and it is desired to find ϕ formula (11) may be written

$$\frac{1-\cos(\phi-\varphi)}{\sin\phi}\frac{H}{h} = (1-\sin\varphi) = a$$

The second member of this equation is a known quality and may be called a. By developing the numerator of the first member, dividing by sin ϕ, and then substituting for sin and tan ϕ their values in terms of $\tan\frac{1}{2}\phi$ it reduces to a quadratic having $\tan\frac{1}{2}\phi$ as the unknown, the solution of which gives $\tan\frac{1}{2}\phi =$

$$\frac{a+\sin\varphi}{1+\cos.\ \varphi} + \sqrt{-\tan^2\tfrac{1}{2}\varphi + \left(\frac{a+\sin\varphi}{1+\cos\varphi}\right)^2} \qquad (13)$$

This determines the slope for rupture.

For example let it be required to find the maximum slope for an excavation 25 feet deep when $\varphi = 30°$ and $H = 5$ feet. Here

$$a = \tfrac{5}{6}(1-0.5) = 0.1$$

and then from (13)

$$\tan\tfrac{1}{2}\phi = \frac{0.1+0.5}{1.866} + \sqrt{-0.0718+0.1034}$$

$= 0.499$. Hence $\frac{1}{2}\phi$ is about 26½° and the maximum slope ϕ about 53°.

9. EQUATION FOR A PERMANENT BANK. In practice it is desired to determine h or ϕ so that the slope may be stable and permanent. To deduce an equation for this case consider again Fig. 3, and let BM be any plane through the foot of the slope making an angle x with the horizontal. As x varies the forces P and N vary and it is easy to see that the weakest plane is that for which the expression $\frac{P-fN}{l}$ equals a maximum. As in Art. 7, it may be shown that the value of x rendering this a maximum is

$$x = \tfrac{1}{2}(\phi+\varphi) \qquad (14)$$

Now it is required that rupture shall not occur along this plane, hence

$$P < f\,N + c\,l$$
$$P - f\,N < c\,l$$

or if n be a number greater than unity, called the factor of security

$$n(P-fN) = c\,l \qquad (15)$$

Rupture can now occur only when the weight W becomes n times that of the prism of earth above the weakest plane, To adapt this equation to practical use it is only necessary to subsitute for P and N their values in terms of x and then to make x equal to $\frac{1}{2}(\phi+\varphi)$. The substitution is performed exactly as in Art. 7 and leads to the following result,

$$n\,h\,(1-\cos(\phi-\varphi) = H(1-\sin\varphi)\sin\phi \qquad (16)$$

which is the required equation of stability.

If n is unity this of course reduces to the case of rupture as given by (11). The value to be assigned to the factor n can only be determined by observation and experiment on existing slopes. Probably about 1.5 or 2 will prove to be sufficient.

10. HEIGHT FOR A GIVEN SLOPE.—When ϕ is given the value of h is derived at once directly from (16), thus

$$h = \frac{H(1-\sin\varphi)\sin\phi}{n(1-\cos(\phi-\varphi)} \qquad (17)$$

This shows that the height for security should be $\frac{1}{n}$th of that for rupture. Thus it was shown in Art 8, if $H = 6$ feet, and $\varphi = 30°$ that the limiting height for a slope of 45° would be 62 feet. Hence with a factor of security of 2 the height would be 31 feet, and with a factor of 1.5 the height would be 41 feet.

(TO BE CONTINUED)

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Connecticut Civil Engineers and Surveyors Association.

The Sixth Meeting of the Association will be held at Waterbury, Conn., Grand Army Hall, No. 47 East Main street, on Wednesday, April 15th, 1885. Headquarters will be at the City Engineer's Office. Special rates have been secured at the hotel (Scovill House.)

PROGRAMME.—Opening Exercises: "The Bristol Water-Works," by R. D. Barnes, of Bristol, Conn. "The Waterbury Water-Works," by N. J. Welton, of Waterbury, Conn. "The Hartford Water-Works," by Henry W. Ayres, of Hartford. Visit to public works of Waterbury.

D. C. SANFORD, Secretary.

ENGINEERING NEWS three months for One Dollar.

WATER.

THE Chattanooga, Tenn., Water-gas company are arranging to lay five miles of additional pipe.

THE Manheim, Pa., water-works are well under way. Five miles of mains are to be laid and the pumping machinery is due in a few weeks.

GROUND is broken for the construction of the Belleville, Ill., water-works, a speech was made by Mr. Ef Abend, the President of the company, and the Mayor o the city cast the first shovel full of dirt.

J. D. Cook, C. E., H. C. Cotter, Supt., J. A. Grauf, Chief Engineer and D. C. Shaw of Toledo, Ohio, have been visiting a number of western cities, with an eye to an extension of the Toledo water-works system.

A FRANCHISE for the construction of Water-works in Waterford, N. Y., has been granted to Joseph C. Platt Jr., and others, of Waterford, and Hinds, Moffet & Co., of Watertown, N. Y.

THE City Council of Nashville, Tenn., has authorized the issue of $450,000 Water-works bonds, bearing 6 per cent. interest and maturing in 1915. Roosevelt & Son of New York are reported to have offered to take the whole issue at a premium.

ACCORDING to the report of the New York Fire Department for 1884 as nearly as can be estimated 44,093,600 gallons of water were used by the land engines of the Department in extinguishing fires, including the quantity taken from the rivers; and in addition thereto an estimated quantity of 9,531,300 gallons of river water was used by the two floating engines, making an aggregate of 53,624,900 gallons.

NEWS OF THE WEEK.

Railroads, Bridges and Canals.

The Rhode Island Locomotive Works have nearly completed thirty locomotives for the Brooklyn elevated railroad.

Northern Aroostoock R. R.—Moses Burpee, C. E., is to make a survey for a proposed railroad from Danforth to Houlton, Maine. Length of road will be 38 miles.

A Bridge over the Jordan.—A Bridge is to be constructed over the River Jordan, near the ancient city of Jericho, by order of the Turkish Government. It will be 45 metres long and 5 metres wide.

Montreal is to have an inclined railway running up the side of the mountain to Mount Royal Park. Work has been begun and the contractors hope to have it finished by June 1. The trip of 505 feet will be made in one minute.

The Central American and Pacific Railway and Transportation Company now has seventy-two miles completed and in operation, and has an equipment of seven locomotives, twelve passenger cars and eighty-four freight cars.

West Shore Connection.—The Troy *Press* has additional information tending to confirm the rumor of the construction by the Troy & Boston of a branch which will connect it with the West Shore near South Schenectady.

A New Chicago Line.—STREATOR, ILL., March 31.—Articles of incorporation have been issued to the Chicago and St. Louis Railroad, with a capital stock of $10,000,000. This will be a continuation of the old Chicago, Pekin and Southwestern, from Pekin to St. Louis.

The Susquehanna and Mahoy Railroad Company was chartered April 7 with a capital of $150,000. The road will be fifteen miles long, and will run through Jefferson County to a point on the waters of Little Clearfield Creek, at or near Watts' saw mill, in Clearfield County.

National Park R. R.—The engineer in charge of road improvements of the Northern Pacific in the National Park states that the new road to the Mammoth Hot Springs Hotel, which follows the Gardner river: the new road up the canyon of the Gardner to Swan Lake, avoiding the hills, as also the bridge over the third crossing of the Gibbon river, will be completed and ready for use June 1. The hotels will be opened June 15.

Winona, Alma & Northern R. R.—Sioux City advices state that the Burlington will resume work upon the Winona, Alma & Northern about the 15th inst. The cause of the suspension of work is said to have been to give time for negotiations to be made between the Burlington and Illinois Central for a joint use of the tracks of these two companies between Chicago and Dubuque. The road is to be finished this season to St. Paul.

The Minneapolis, Sault Ste Marie and Atlantic is to be extended at once from Bruce, Wis., across the Chippewa River, thirty miles toward the Wisconsin River and it is hoped to reach that river, 100 miles from the present terminus, before next winter, because that will give access to the great pineries to be ultimately traversed by the road.

The Oroya, Peru R. R.—The N. Y. *Sun* of April 8, says that Mr. M. P. Grace, of Wm. R. Grace & Co., of this city have entered into a contract with the Peruvian Government to complete the Oroya R. R. and its extension to Cerro de Pasco. 136 miles of track is to be laid from Lima to Oroya, only a few miles from the rich silver deposits of Cerro de Pasco; this latter point is 13,200 feet above the sea. The work already done has cost $30,000,000, and Mr. Grace's contract gives him control and posession of the line for 99 years and exclusive permission to build a road to the mines for 25 years.

Mobile & West Alabama R. R.—The organization was perfected on March 28. The officers elected were: T. G. Bush, President: J. T. Miller, Vice President; Thos. P. Miller, Duncan Parker, G. B. Clark and Thos. Henry, directors. Mr. Milner will likely have charge of the survey. He believes the object of the Mobile Grand Trunk parties subscribing the entire stock was merely for the purpose of effecting organization. Col. Milner says the board will have his hearty co-operation, and expects eventually to succeed in building this important road.

White Mt. Railway.—The extension of the Pemigewasset Valley railroad, from North Woodstock to Fabyan's, is under consideration. This would make the shortest possible route from Boston to the White Mountains, and would open up an immensely valuable tract of thousands of acres of timber land. Before the season of summer travel opens, the northern end of the line having the termini at Fabyan's and Woodsville will be relaid with steel rails, new frogs and safety switches. The cost will be over $100,000.

California and Nevada R. R.—On the (29th) ult. we opened for traffic the first section of this road from Oakland to San Pubio a distance of ten miles. About 7 miles of grade is ready for the ties and iron (of which have been purchased a sufficient quantity to complete the first division to Walnut Creek Contra Costa Co., a distance of 30 miles). This opens up one of the best fruit and grain sections of state of California and it is expected to have the road completed to San Francisco by Nov. 1st, 1885. The Chief Engineer is Calvin Pratt.

Guatemala Railroad.—The city of Guatemala has recently been placed in direct communication with the port of San Jose on the Pacific coast by the opening of a new line of railway. The total length of line is seventy-two miles—single track and the narrow three-feet gauge. Between Escuintla and Palin, a distance of nineteen miles, the road rises over 3,000 feet; the total rise between San Jose and Guatemala is within a few feet of 5,000. The entire rolling stock was imported from the United States.

The Chicago, St. Paul, Minneapolis and Omaha people have completed a survey for an extension of their road from River Falls southeast to Ellsworth, a distance of twelve miles. According to the charter originally granted by the Wisconsin Legislature, the Omaha company was to have constructed a line from Lake Superior to the Mississippi. This line was built as far as River Falls, but was never continued beyond that point. The present Legislature changed the provisions of the charter, and the Omaha is no longer compelled to build to the Mississippi, but instead will build to Ellsworth. The report that this line would be continued to Red Wing is without foundation.

Boston, Albany & Chicago R. R.—A bill has been passed in the Massachusetts legislature incorporating the Boston, Albany & Chicago company, with a capital of $60,000,000 for the purpose of buying the stock of the Boston & Albany, the Boston and Lowell, the Fitchburg and the Central Massachusetts roads and consolidating these companies with the new corporation. When this is done it is proposed to buy the Hoosac Tunnel and the Troy & Greenfield road, and then lease any road which may form part of a continuous line from Boston to Chicago. The new company proposes to pay the State 60,000 shares of its stock for the Hoosac Tunnel and Troy & Greenfield road.

The Minnesota & Northwestern.—St. Paul, Minn. April 3.—The grading of the Minnesota & Northwestern road from West St. Paul to Mona, 110 miles, has been practically finished, and the tracklayers will be put at work at Cascade, D. T. as soon as the frost leaves the ground. The entire road is booked for completion by the 1st of July. Abutments and piers for the bridge across the Mississippi have been completed, and the work is to be pushed rapidly. The iron draw-bridge span, when completed, will be the largest in the world. The draw will weigh 500 tons, of which 200 tons will be of steel and the remainder iron. It will be 412 feet long, and when it is opened by being swung round on its center, there will be a clear space of nearly 200 feet on each side. The grade on the draw will be fifty-three feet to the mile, with a curvature of 4°. The piers will be on a 55° skew.

Maine Grade Crossings.—The following Act was passed by the Maine Legislature on March 5:—

An act in addition to section seventy-six of chapter fifty-one of the Revised Statutes, in relation to railroads crossing each other at grade. *Be it enacted etc.*, as follows:

When railroads cross each other at grade, the parties operating the railroad last located there, shall build and maintain a suitable signal station at such crossing, at which a competent signal official shall be kept at the joint expense of the parties operating the railroads. The signal shall not be set for a train to cross, until the engine of such train shall have arrived within five hundred feet of the intersection and stopped; and no train or engine shall cross the track of the other road, until the proper signal for it to cross shall have been set in position by the signal officer. Only one train or engine shall be allowed to cross under one setting of the signal unless coming from opposite directions on the same railroad. When the signal has been set for the trains on one of the railroads, it shall not be changed until those trains shall have passed entirely over the crossing. When trains on both railroads approach the crossing at about the same time, preference shall be given to passenger trains and the signal shall be set for the trains on each road in alternate order.

From Memphis to Yazoo City.—President Clark, of the Illinois Central Railroad, has written a letter to City Engineer Meriwether, of Memphis, Tenn., stating that his company will positively build a connecting line from Memphis to Yazoo City, and asking him to make all the necessary surveys for his entry into Memphis. The Memphis Legislative Council at its next meeting will be petitioned for the right of way for this new road.

The Southern Railroads.—The Roanoke and Raleigh Railroad has been incorporated in North Carolina to build a road from Halifax to Raleigh, N. C. The incorporators are: J. H. Rice, of Maine; George B. Loring, Washington, D. C.; Hon. William Windom and others.

The legislature of North Carolina, at its recent session, granted charters to the following railway corporations:—Cabarrus and Stanley; Cashie and Roanoke; Chesapeake, Norfolk and Carolina: Catawba County and Tennessee Line; Carthage; Caswell; Durham and Roxboro; Mt. Holly and Denver; Oxford and Clarkville; Pittsboro; Reidville and Dan River; Roanoke and Raleigh; Roanoke and Tar River; Spartanburg and Shelby; Southern and Western Air Line; and Wilmington, Onslow and East Carolina.

The Memphis and Raleigh Railroad Co. has applied for a charter to build a narrow gauge road from Memphis to Raleigh, Tenn., a distance of 7 or 8 miles. The following citizens of Memphis are the incorporators: John Donelly, Jno. Scheibler, J. M. Coleman, W. N. Brown, and D. H. Poston. The capital stock is $50,000.

Wilmington, N. C., March 30.—President Bridgers, of the Wilmington and Weldon railroad company, has advertised for proposals to build a branch railroad from a point near Wilson to Fayetteville, a distance of 70 miles. It is officially stated that the road will be completed during the summer of 1886. This is a part of the projected line known as the Short Cut from Wilson, N. C., to Florence, S. C., which, when completed, will shorten the time on the Atlantic Coast line two and a half hours.

The Soudan Railway.—There has been already shipped everything required for the laying down of 100 miles of railway. This includes, at a moderate computation, 10 000 tons of 56 pounds steel rails for the main line, and 2,470 tons of smaller rails for the gauge line; more than a quarter of a million sleepers, besides 600 tons of steel sleepers for the 1 foot 6 inch gauge line; and 12 turntables. The rolling stock includes 28 locomotives, and a quantity of duplicate portions of engines in case of accident. The passenger traffic will be conducted in six saloon and 26 third class carriages, with 10 brake vans; while for stores and ammunition are provided 250 ballast trucks to carry eight tons each, and upwards of 300 trollies and wagons. Fitted to the 4 feet 8½ inch gauge also is a double-tank water car of a capacity of 4,000 gallons, and there are six single tanks on trollies. Signal-boxes, levers, hand and steam cranes, sheerlegs, portable engines, winding gear, boilers, steam pumps, artesian well pumps, galvanized iron tanks, water-cocks, pipe-testing machines, of every size, sort, capacity, horse-power, and gauge, have all been provided. Of wrought-iron steam tubing, tested to 1,200 pounds a square inch, for conveying water, there are in all more than 30 miles—with diameters varying from 4 inch to ¾ inch. Also 11 water condensers, producing over 40,000 gallons a day; and the Admiralty supply the "Zurich" and another vessel for condensing purposes, each with apparatus and 100 tanks of 300 gallon capacity; two 130 ton iron barges are also supplied, and a steam launch and six wooden pontoons for landing purposes. For the laying and repairing of plant two complete fitting shops, with all necessary appliances, fitters', smiths', and platelayers' tools have been shipped. Messrs. Merryweather and Sons, of Greenwich, have also received an order from the Admiralty and War Office for five portable steam pumping engines, and quantity of hose, for the Suakim water supply, and Messrs. A. and J. Stewart, of Glasgow, are, as already announced, supplying the Government with pipes at the rate of about one mile per diem. Messrs. Lucas and Aird have also specified for a number of Norton's "Abyssinian" tube wells, with pumps and driving apparatus. Messrs. Le Grand and Sutcliff, contractors to Her Majesty's War Department, have received orders to prepare these for immediate despatch to Suakim.—London *Contract Journal*, March 25th.

Contracting.

Not a Cavern after all.—Work has been commenced on the foundation for the new court house at Knoxville. The cavern which broke out within the foundation line has proven to be an old cistern, which had been built years ago and covered up.

Cleveland, O., Contracts.—Proposals for dredging the river and removing bars and other obstructions between the Lake Shore bridge and the new canal transfer lock and also in the old river bed, have been received at the Board of Improvements office. The following bids were made: for excavating per cubic yards, L. P. and J. A. Smith, 28 cents; W. J. Starkweather, 29 cents; William E. Rooney, 17 cents; Michael Kerr and others, of Erie, Pa., 22 cents; Jesse Simms, 25 cents. For each hour in removing logs and like obstructions the proposals of these five bidders were respectively $12, $11, $8, $8, and $8. Mr. Rooney, the lowest bidder, resides in Toledo.

New Haven, Conn., Sewer Contracts.—The City Engineer opened on April 1, sewer bids, the successful parties and prices being generally as follows:—Pile and timber foundations, C. S. & E. R. Redfield, with piles at $1.50, grillage at $6.00. Sewers on James Street to C. W. Blakeslee & Sons, with 45 inch cut stone walls, $16.23; 45 inch rubble walls, $10 03; and brick sewers in from 8 to 21 feet cutting and from 45 inches to 24 inches in diameter, at prices ranging from $5.29 to $4.50; catch basins bid at $105.00, and manholes at $54.50. Sewers on Henry Street to M. S. & J. H. Austin, with 30 inch sewers, 8 inch inverts and 15 feet cutting at $5.00; 24 inch, $3.50; 24 inch, 4 inch inverts, $2.88; pipe sewers, 18 inches to 12 inches and about 12 feet cutting, from $2.25 to $1.10; 6 catch basins $100.00 each, manholes $40. Sewers on Elm and Morton Streets to L. O'Brien, pipe sewers from 15 to 12 inches and 11 feet cutting, $1.05 to $1.00. Grand Street sewers, to M. Kehoe, cutting 11 to 14 feet, pipe sewers, 15 to 12 inches, from $2.00 to $1.30; catch basin, $104.00, manhole, $54. Whiting Street sewer, to M. Kehoe, cutting 11 feet, pipe sewers 15 to 12 inches, bid from $1.90 to $1.35. St. Rouan Street pipe sewer to L. O'Brien, 15 inches, cutting 7 feet, bid $1.50.

Granite Wharf.—The following is an abstract of the proposals received by the Supervising Architect for the construction of a granite wharf for the custom house, &c., at Charlestown, S. C.:

Bodwell Granite Company, Rockland, Me., $32,295.
C. J. Hall, Belfast, Me., $40,000.
E. R. White, Charlestown, S. C., $41,411.90.
W. S. White, Rockland, Me., $36,830.
G. A. Denning, Augusta, Ga., $31,360.
Stone Mountain Granite Company, Atlanta, Ga., $47,498.
McClenahan Bros., Port Deposit, Md., $38,300.
Joseph Ross, Ipswich, Mass., $33,451.

Wilmington Harbor, Cal.—The following is an abstract of the proposals received by Lieutenant Colonel Geo. H. Mendell for delivering stone to be used in improving Wilmington Harbor, Cal.:

Ed. A. Von Schmidt, $1.97.
Edgar W. Emerson, $2 29.
John Calvert & W. T. Fielding, $2.68.
San Francisco Bridge Company, $3.44.

Belle River, Mich.—The following is an abstract of the bids received by Colonel Poe for improving the ice harbor at Belle River, Mich.:

Thomas M. Hubbell, Saginaw, Mich., 20c. per cubic yard.
Carkin, Stickney & Cram, East Saginaw, Mich., 25c.
Contract awarded to Mr. Hubbell.

Custom House.—The contract for labor and material on the custom house at Greensborough, N. C., has been awarded to L. D. Wittcutt, of Boston, Mass., at his bid of $24,903.

Elevators.—The following is a synopsis of the bids received by the supervising architect for two hydraulic passenger elevators, two mail elevators and one ash lifter for the custom house, &c., at Cincinnati, Ohio:

Henry J. Reedy, 532 Canal street, New York, and 83 Illinois street, Chicago, Ill., $24,975.
Stokes & Parrish, Philadelphia, Pa., $21,500.
Whittier Machine Company, Boston, Mass., $25,850.
Ellithorp Air Brake Company, Chicago, Ill., $22,998, $26,515, $24,198 and $27,745.
George C. Howard & Co., Philadelphia, Pa., $19,500.
Crane Bros., Manufacturing Company, Chicago, Ill. $19,800 and $21,800.
Howard Iron Works, Buffalo, N. Y., $19,745.

Iron Work.—Judges of Jackson Co. Court, Mo., have just awarded to Mr. J. W. Davis, agent for the Detroit Safe Lock Company, the contract for iron work in the new jail in this city. It consists of building eighteen new cells, with all the latest improved patents used in their construction. The Detroit safe company is well known throughout the country, their work being unsurpassed, as is proved wherever used. The firm will hereafter be represented in Kansas City by Messrs.

Davis & McCleery, whose office is at the corner of Sixth and May streets. They are now placing in their establishment a sample line of the company's superior safes, and in a few days will be prepared to show their workings and give specifications to those who desire.

City Hall, Grand Rapids, Mich.—In compliance with advertisements send out by the board of public works for bids to construct the new city hall, in compliance with the plans and specifications accepted from Mr. E. E. Myers, of Detroit, provided the contract to build the structure could be let for $150,000, they met recently and opened the bids, which were from six different firms, none of which were from Grand Rapids. The bids were as follows: Wm. H. Myers & Sons, of Hillsdale, $175,000 and $171,000 with regular range work: Chas. Pierce & Co., Indianapolis, $184,700.25; Bentley & Nolan, Milwaukee, $216,856.62; Davison & Anderson, Toledo, $193,243; Angus & Gindele $210,540 blue stone, $217,650 nolete, $232,750 superior; the Young & Farrell D. S. Co., Chicago, $205,713.45. Samples of the stone were exhibited and examined by the members of the board. All bids were rejected, and the work was advertised again. None of the three contractors in Grand Rapids presented their bids to the board, probably because they did not wish to give away the amount of their bids and thinking that the contract would not be let on the present bids.

Iron Tower.—The following is a schedule of the proposals for the construction and delivery of a tower for Delaware Breakwater Beacon Light, Del., opened March 13, at the office of the engineer of the fourth light house district:

Colwell Iron Works, New York city, $5,875.
H. A. Ramsay, Engineering Works, Baltimore, Md., $5,985.
Phœnix Iron Company, Trenton, N. J., $6,450.
Snead & Co., Iron Works, Louisville, Ky., $7,129.
Robert Daley & Co., New York city, $7,848.65.
G. W. & F. Smith, Iron Company, Boston, Mass., $7,500.
West Point Foundry Association, New York city, $7,565.
Julius Jonson, New York city, $7,780.
Tanner & Delaney Engine Company, Richmond, Va., $7,909.
Hugh Ketcham & Co., Iron Works Indianapolis, Ind., $9,622.10.
Lebanon Manufacturing Company, Lebanon, Pa., $11,030.

The contract has been awarded to the Colwell Iron Works.

Street Paving and Clay Pipe.—The bids received by Wm. E. Cutshaw, city engineer of Richmond, Va., for street improvements in that city were opened on the 17th inst., and on the 18th the following awards were made:

New brick paving (material and workmanship) per square yard 64 cents, to A. L. Philips.

Taking up, relaying and repairing all brick paving (material and workmanship) per square yard 18 cents, to Charles S. Thurston.

Furnishing and setting all granite flagging per square foot 40 cents, to J. B. Mitchell & Co.

Furnishing and setting all circular granite curbing six inches wide on top face per linear foot 50 cents, to J. B. Mitchell & Co.

Furnishing and setting all granite corner curbing $5 each, to J. B. Mitchell & Co.

Furnishing and setting all stone work for street basins $15, to J. B. Mitchell & Co.

Furnishing and setting stack covers for street basins per square foot 40 cents, to J. B. Mitchell & Co.

Furnishing and setting all plain granite curbing 18 inches deep per linear foot 67½ cents, to Richmond Granite Company.

Hoffman's Rosendale cement (delivered on ground) per barrel $1.26, to Robert Wendenburg.

Iron frames and covers for street basins $3.20 each, to Joseph Hall & Co.

Furnishing and delivering on ground: 12 inch terra cotta pipe, per foot, 28 cents; 10 inch 20 cents; 8 inch 14 cents; 6 inch 11 cents; 12 inch branches 50 cents; 10 inch branches 35 cents; 8 inch branches 25 cents; 6 inch branches 20 cents, to McMahon, Porter & Co., New Cumberland, W. Va. Any size or shape not mentioned above 62 per cent. off price list. Resetting curbing per linear foot, 4¾ cents; resetting flagging per square foot, 3¾ cents; resetting granite corner curbing, each 50 cents; setting granite corner curbing, each 75 cents; jointing curbing per joint 5 cents; jointing flagging per joint 3 cents; redressing curbing per square foot 15 cents; redressing flagging per square foot 10 cents.

Furnishing all material (except cement) and workmanship for sewer 16x24 inches (excavation for which is to be done by city) per thousand bricks $16 48; slacks to sewer per thousand bricks, $15.50, and street basins per thousand bricks, $15.75, to Lewis A. Jacob.

The contract for stone paving will be awarded during this week.

The committee on streets of the Richmond, Va., council held a meeting in the office of City Engineer W. E. Cutshaw to examine proposals for pavement of streets. The two principal bidders were Messrs. A. Bick and Thomas Barry. The contract was awarded to Mr. Barry—Mr. Bick's bid being 68⅝c. per square yard, and Mr. Barry's being 67 8-10c. per square yard.

Metal Work.—The following is a schedule of proposals to construct and deliver the metal work for the Rebecca Shoal Light House, Florida, opened March 21, 1885, at the office of the light house board:

West Point Foundry Association, New York city, $11,031.50.
Snead & Co., Iron Works, Louisville, Ky., $11,227.
Colwell Iron Works, New York city, $11,873.
H. A. Ramsay Engine Works, Baltimore, Md., $11,900.
Phœnix Iron Company, Trenton, N. J., $13,500.
Robert Deely & Co., New York city, $14,250.

The contract was awarded to the West Point Foundry Association.

Iron Columns—Beams, Etc.,—The following is an abstract of the prososals received by the supervising architect in response to a circular letter, dated March 16, for iron columns, beams, etc., for the court house at Jefferson city, Mo:

Pencoyd Iron Works, Philadelphia, Pa., $1,085.
Pittsburg Bridge Company, Pittsburg, Pa., $1,090.
Snead & Co., Iron Works, Louisville, Ky., $1,160.
Scherpe & Kohen, St. Louis, Mo., $1,131.
New Jersey Steel and Iron Company, New York, $1,049.13.
Carnegie Bros., Pittsburg, Pa., $1,141.04.
Phœnix Iron Company, Philadelphia, Pa., $1,081.
Dearborn Foundry Company, Chicago, Ill., $1,148.
Haugh, Ketcham & Co., Indianapolis, Ind., $1,395.60.
Etna Iron Works, Pittsburg, Pa., $1,110.
L. M. Morris, Philadelphia, Pa., $1,128.

Cast-iron Pipes.—The following bids for 30,000 6 inch cast-iron water pipes and special castings, fire plugs, and water gates were received by the District engineer commissioner recently:

Camden Iron Works, Camden, N. J., pipe $13,053.60; special castings, $53 per ton.
Fox & Drummond, New York, pipe $13,340.25; special castings, $49 per ton.
Cincinnati and Newport Iron and Pipe Company, pipe, $14,076.72; special castings, $56 per ton.
Gloucester Iron Works Company, Gloucester, N. J., pipe, $14,954.31; special castings, $67.20 per ton.
John McClelland, Washington, D. C., fire plugs, $70 each; 6 inch gates, $68 each; 10 inch gates $70 each.
J. C. Jones, Washington, D. C. 6 inch gates, $70 each.
E. G. Smyser bid on fire plugs of various kinds, ranging from $46.50 to $78 each.

Dredging—Potomac River.—The following is an abstract of the proposals for dredging 200,000 cubic yards in the tidal reservoir and 500,000 cubic yards in the Virginia channel Potomac River:

Benson & McNee, San Francisco, tidal reservoir, 15c. per cubic yard; total, $30,000; Virginia channel, 15c. per cubic yard; total, $75,000.
Morris & Cumming's Dredging Company, New York city, reservoir, 25½c. per cubic yard; total, $51,000; channel, 25½c. per cubic yard; total, $127,500.
Atlantic Dredging Company, Brooklyn, N. Y., reservoir, 23½c, per cubic yard; total, $50,000; channel, 23½c per cubic yard; total, $117,000.
American Dredging Company, Philadelphia, Pa., reservoir, 25c. per cubic yard; total, $50,000; channel, 25c. per cubic yard; total, $125,000.
Ross & Sandford, Jersey City, N. J., reservoir, 20c. per cubic yard; total, $40,000; channel, 18½ per cubic yard; total, $92,500.

The contract has been awarded to Benson & McNee.

Excavating Middle Neebish.—The following is an abstract of the bids received by Colonel Poe, Corps of Engineers, for excavating Middle Neebish, Hay Lake Channel, St. Mary's River, Mich.: The first bid in each case is for excavating above twenty foot grade, and the second for excavating above fourteen-foot grade. In all bids the price is per cubic yard.

Charles S. Barker, Sault Ste. Marie, Mich., 1, $2.50; 2, 2, $2.50.
Hickler & Green, Buffalo, N. Y., 1, $2.40; 2, $5.25.
Carkin, Stickney & Cram, East Saginaw, Mich., 1, $2.98; 2, $5.50.
Chicago Dredging and Dock Company, Chicago, Ill., 1, $3.50.
Horatio Truman, Manitowac, Wis., 1, $4.
Charles F. Dunbar, Buffalo, N. Y., 1, $4.50; 2, $6.
Castle Sutherland, East Saginaw, Mich., 1, $3; 2, 60 cents.

Awarded to Mr. Sutherland at 60 cents.

Grading Streets.—The following proposals for grading the streets of Philadelphia were the lowest of those opened on the 23d inst. by John D. Estabrook, Chief Commissioner of Highways:

Ninth street, from Cumberland street to Lehigh avenue, Thomas M. Cleary, at 22¼ cents per cubic yard.
Martin street, from Mitchell street to Ridge avenue, I. F. Bernard, at 16¾ cents per cubic yard.
Centre street from Webster street to south west of Clay street, A. Anderson, 18 cents per cubic yard.
Clay street, from Cnurch street to southeast of Centre street, G. Hoffner, at 17 cents per cubic yard.
Wright street, from Twenty-fifth to Twenty-sixth street, W. Sharkey, at 23¼ cents per cubic yard.
Sharswood street, from Twenty-fifth to Twenty-sixth street, W. Sharkey, at 23¼ cents per cubic yard.
Lauriston street, from Ridge avenue to Richter street, W. C. Watson, at 24 cents per cubic yard.
Dawson street, from Ridge avenue to Richter street, Thomas Schofield at 20 cents per cubic yard.

The Northern Central is expending $125,000 in terminal improvements at Baltimore.

Masonry and Superstructure of Bridges.—Sealed proposals will be received at the county auditor's office of Franklin County, Ohio, until Friday, April 17, 1885, at 12 o'clock noon, for the masonry and superstructure for a bridge over the Scioto River, at Dublin, Washington township, Franklin County, Ohio. Said work is to be done in accordance with plans and specifications and profile of said work on file in county auditor's office. The county commissioners reserve the right to reject any or all bids.

A Ship Canal Scheme.—The construction of a ship canal from Rochester up the valley of the Beaver River to Lake Erie is being talked of, and will probably be undertaken before very long. The projected canal will pass through Beaver, Lawrence, Mercer, Crawford and Erie counties. There are many advantages to be gained, among them the fact that these counties are rich in deposits of limestone which now is transported to Western Pennsylvania at a cost of 60 cents per ton, and could be taken by water were the canal constructed at a cost of only 10 cents. The advantages to the iron men of the Keystone State are by no means the only ones, or even the most important, to be gained by the construction of such a water-way.

Miscellaneous.

The Geological Survey of Algeria, long suspended has lately been resumed, and it is hoped that a new and revised edition of the map may be ready in 1887. One, on an exceptionally large scale, of the environs of Algiers, is in course of execution, based on the map prepared by the military engineer, of the scale of 2000.

The English, French and German mails bound for the East are now sent *via* Brindisi, but a line of railway is building, in accordance with the terms of the Berlin Treaty, from Salonica on the Mediterranean to Uskiub, and when it is completed all mails will be sent that way, effecting twelve hours saving in train. The change is expected to do much for Belgrade, the Servian capital city.

Removing Scale from Locomotives.—An easy method of facilitating the removal of lime scale from the fire-boxes and flues of locomotives has been discovered by B. Warren, master mechanic of the Indianapolis, Bloomington & Western railroad. He painted them with petroleum paint for the purpose of preventing the formation of this scale. While it did not prevent it, the paint rendered its removal easy, a tap of a hammer being sufficient to clear a flue of scale that would ordinarily require two or three hours to remove.

A Brazilian Dam.—An immense dam is to be constructed in Brazil, under the direction of French engineers. The main portion will be 940 feet long by 58 feet high, and two smaller ones will close side depressions. It is calculated that this work will back the water over some 1,500 acres, and retain 14,900,000 cubic meters of water, sufficient, it is claimed, to provide for all the cattle of the region during a period of three years, and for the irrigation of 5,000 acres of flat bottom land alongside the river bed below.

River and Harbor Improvements.—The Army engineers in charge of river and harbor improvements will be able to continue work notwithstanding the failure of Congress to pass the river and harbor bill. There is about $9,000,000 of the $14,000,000 appropriated at the close of the first session of the last Congress remaining in the Treasury. A considerable portion of this is pledged by contracts already entered into for work to be done during the spring and summer of this year. Yet there is a sufficient balance on hand to warrant the continuance of nearly all the improvements until late in the fall. The last appropriation was made in July, 1884, and it was near September before advertisements commenced to be issued. It was so late in the season that very little work in the South could be done, and there only when the rivers to be improved were not swollen. In most parts of the North but little work was done. For such works the entire appropriation made is still available, and will be expended as advantageously as possible. Nearly all the improvements will suffer to a more or less extent owing to the injury which will be done if they are not pushed to completion when once started. The Mississippi River will be the greatest sufferer. The improvements on the Portland, Ky., St. Mary's, Mich., and Des Moines, Iowa, canals will not have to be discontinued as soon as the appropriation is exhausted owing to a clause in the bill which passed authorizing the engineer in charge to draw upon the Treasury, through the Secretary of War, for operating expenses and repairs, without reference to any appropriation. In view of these facts there is no cause why contractors should complain of the prospect for this season, while it is true that work will not be so plentiful nor prices so good as if the river and harbor bill had passed, yet there is sufficient money in the hands of the Corps of Engineers to let a fair number of new contracts.

To make Paris a Seaport.—The old project of making Paris a seaport has been revived by an engineer, M. Bouquet de la Grye. He proposes to deepen the Seine between Rouen, where large vessels can sail or be towed up from the sea, and Poissy, a pleasant summer resort of many Parisians, within easy distance of the metropolis. The distance to be deepened is something over ninety-three miles. The projector, however, says nothing of the dangers likely to result from the numerous islands which stud the Seine between Poissy and Rouen, and which would render river navigation exceedingly dangerous for vessels of large tonnage, such as those that pick their way so carefully from Havre to Rouen.

Index to Periodical Literature.

Air Locks. *see* **Foundations, Pneumatic.**

Bridges, Highway.—*Economy in Highway Bridges.* Our investigation to determine the most economic number of panels and depth of truss for all ordinary highway bridges, also the length of span at which it it is better to change from pony truss to through bridge, and from single to double intersection. Tables. Paper by J. A. L. Waddell. *Proc. Eng. Club Phila.*, 1883, III. S. pp. 281 to 298.

Bridge, Priay.—*Pont de Priay sur l'Ain.* A detailed description of a masonry bridge of 5 spans, each of 26 meters (about 85 feet) span, and 3.34 meters rise (about 11 feet), the foundation and superstructure are very fully described and illustrated with plans, elevations, details, etc. It is remarkable for its small cost, as well as its beautiful appearance. *Le Genie Civil.* Mar. 7, 1885, pp. 293 to 295.

Bridge, Sutlej.—*Le Pont de l'Impératrice sur le Sutlej.* (India). The bridge has 16 spans of 79.2 meters each (about 257 feet). The foundations consist of three tubes for each pier, which pass through sand into clay to a depth of about 100 feet. The tubes are of iron lineb with wood, strongly pined and hooped in place. The sand and clay are removed from the interior by buckets to a short distance below the bottom, they are then filled for a short length of the bottom with beton, then with sand to within a few feet of the top, and are topped off with beton. The article is well illustrated with general views and details. The superstructure is not described. *Les An. des Travaux Publics.* Mar. 1885, pp. 1305 to 1306.

Bridge, Tardes.—*Lancase du Viaduc de la Tardes (France.)* An account of the erection of a lattice-truss bridge, of three spans with but slight use of false works. The center span of 104.55 metres (about 340 feet) was erected entirely without false works, being projected from one pier directly to the other in one direction. The article is fully illustrated, with general views, elevations at successive stages of the works, etc., and detailed descriptions and sketches of the special apparatus used. By Ch. Talausier. *Le Genie Civil*, January 24, 1885, pp. 197 to 201.

Bridge, Tower.—*Design for the Tower Bridge (London.)* Comprises three spans, the central one, which opens, being of 250 feet opening. By means of shafts down the central piers, communication is effected with a subway under the bed of the river, so that traffic is not interfered with. The transfers between bridge and tunnel are made with hydraulic elevators. Illustrated. *Engineering*, January 16, 1885, pp. 64 and 65.

Caissons. *see* **Foundations, Pneumatic.**

Civil vs. Military Engineers.—A very spirited and interesting discussion of the question of the exclusive employment of military engineers in the charge of the river and harbor improvements by the general Government, is being carried on in the columns of *The Engineering and Mining Journal*, beginning in the number for March 7, 1885.

Culverts.—A full consideration of certain rules to be followed in the designing of culverts, with several illustrations. *R. R. Gazette*, Jan. 23, 1885, pp. 54 and 55.

Dock Warehouses.—*Etudes sur la Construction et l'Aménagement des Ponts de Commerce.* A detailed description of the warehouses erected at the Docks of Marseilles, illustrated with plan and details of special constructions. Large warehouses at Bremen and Berlin are also described and illustrated. *Anales des Travaux Publics.* March 1885, pp. 1303 to 1305.

Fascines.—*The Fascines and Mattresses of the Delaware Breakwater Harbor Improvement.* A brief description, fully illustrated, of the method of making and sinking. Paper by G. T. Guilliam. *Proc. Eng. Club Phila*, 1884, IV. 1. pp. 36 and 37.

Foundations, Pneumatic.—*Nouveau Systeme de Caisson à Air Comprimé (système Klein, Schmoll et Guertner, à Vienne.)* A description of an air-lock composed of four chambers, so constructed as to permit continuous working, with illustrations, and the method of operating it. A record of its successful use on the Danube. The disadvantages of re-employing caissons are incidentally discussed. *Annals des Travaux Publics.* Mar. 1885, pp. 1315 to 1317.

Foundations, Tubular, *see* **Bridge, Outley.**

Friction, Journal. *Experiments with New Apparatus on Journal Friction at Low Velocities.* A description of the apparatus, with a statement of the principles upon which it is constructed. A record of the tests, the results being shown graphically and compared with the results obtained by them. The subjects of initial friction, normal coefficient at ordinary velocities, proportion of rolling friction in railroad service due to journal friction only, resistance of freight trains in starting, effect of temperature in coefficient of friction, effect of load per square inch of being a coefficient, effect of higher velocities, &c., are considered. By A. M. Wellington, with discussions by R. H. Thurston and others. *Trans. Am. Soc. of Civil Engineers*, CCXCV., Dec. 1884, pp. 409 to 475.

Jervis John B.—*The late John B. Jervis.* A long and interesting sketch of his life and works, with portrait. By Wm. P. Shreve. *R. R. Gazette*, Jan. 23 1885, pp. 49 and 50.

Railroad, Elevated, Pittsburg.—*Elevated Track of the Pittsburg Junction Railroad.* Plans and elevations of the standard girders and posts, accompanied by a brief description. *Railroad Gazette*, March 13, 1885, pp. 164, 165.

Railroad Ferry. *see* **Car Ferry.**

Rails, Light.—*Light Rails.* An elaborate demonstration of the economy in using heavy rails, with tables showing the comparative amount and cost of stiffners, strength and durability in light and heavy rails. *R. R. Gazette*, March 13, 1885, pp. 168 and 169.

Railroad Switches and Signals.—*Interlocking Switches and Signals, Grand Central Depot, New York.* A detailed description of the system erected by the Union Switch & Signal Co., the considerations which complicated the problem of its introduction, the manner of overcoming these difficulties, and the method of operating the flying switch signal. The illustrations include a general plan of the tracks, switches, etc., from the depot at 45th St. to 49th St., an interior view of a signal tower, and sketches of the remaphre signals, and of the double and single slip switches. *Railroad Gazette.* March 13th, 1885, pp. 162 to 164.

Railroad Terminals. *Terminal Facilities of the Pennsylvania Railroad at New York.* A description of the freight docks on the Noth river water front, with maps; the general method of handling freight, with sketches; the freight lighterage equipment of the company, &c. By Gratz Mordecai. *R. R. Gazette.* Feb. 27, 1885, pp. 130 to 133.

Railroad Terminals. *Railroad Terminal Facilities at New York.* A very full description of the New York Central and Hudson River R. R.'s terminal works in New York City, operation of the yards, locks, &c. handling of freight, with many maps and illustrations. By Gratz Mordecai. *R. R. Gazette.* Jan. 23 and 30, 1885, pp. 50 to 52, and 66 to 67.

Market Report of Engineering Materials.

New York, April 9, 1885.

NOTE.—The following Market Report gives wholesale prices on the New York Market unless otherwise stated. It is intended as a general guide to the estimating engineer, and both the range of material and the market location will be extended as rapidly as possible. We give it with this caution, that, as is well understood in business transactions, the amount of bill, distance from market centre and conditions of payment will have a material influence on the final paying prices.

IRON.

STRUCTURAL IRON.		
Angles	2.2c. @	2.6c.
Tee	2.8c. @	3c.
Beams and channels	3.0c. @	3.5c.
Tank	2.1c. @	2.15c.
Shell	2¾c.	
Steel plates, Tank	3c. @	3¼c.
WROUGHT-IRON PIPE., PITTSBURGH.		
Butt welded, black ..Discount	50	
" " galvanized "	40	
Lap welded black "	50	
" Galvanized "	67½	
Boiler tubes	60	
RAILS.		
Steel (large lots at mill)	$26 @	27.00
Old rails	17.50 @	18.00
Old rails, steel	17 @	18
R. R. spikes		3c
R. R. splice-plates	1.65c. @	1.75c.
R. R. Track Bolts	2.35c. @	2.65c.
Barb-wire fencing, galvanized	4¾c. @	5¼c.
" " painted	3¾c. @	4¼c.
Corrugated iron		
Nails		
Iron	2.25	
Steel	2.35	

METALS.

COPPER.		
Lake Superior	11 @	.11¼
Other Brands	10¼ @	10¾
LEAD.		
Com. Domestic	3.60 @	3.70
Lead Pipe	.06¾	
Tin-Lined Lead Pipe	.15	
Sheet Lead	.06¾	
ZINC.		
Sheet	5.15 @	5.25

BRICK.

(Cargoes afloat)		
Haverstraw 1st ..per M.	$6.00 @	6.25
" 2nd "	5.62 @	5.87
Fishkill	4.75 @	5.50
Up-River		
Jerseys	5.25 @	
Long Island		
" pale		
FRONTS.		
Croton red	14.00 @	
" dark	14.00 @	
" brown	12.00 @	
Philadelphia pressed	22.50 @	23.00
Trenton "	22.50 @	23.00
Baltimore "	37.00 @	41.00
Buff "	33.00 @	35.00
Enameled English	65.00 @	130.00
" American	85.00 @	120.00
Fire brick	25.00 @	40.00

CEMENT.

PORTLAND.		
Gibb's English 400 lbs. per bbl	2.75 @	2.90
K. B. & S. " "	2.85 @	3.00
Burham " "	2.70 @	2.85
Keene's fine " "	9.50 @	9.75
" course " "	5.25 @	5.75
Roman	2.75 @	3.50
Langerdorfer German "	2.90 @	2.65
Dyckerhoff, "	2.60 @	2.65
Stettiner " "	2.60 @	2.65
Alsen, " "	2.55 @	2.60
Tieve " "	2.40 @	2.50
Saylor's American	2.15 @	2.40
ROSENDALE cements	0.90 @	1.10

LIME.

Rockland common per bbl	1.00	
" finishing	1.20	
Glensfalls, common	.85	
" finishing	1.05 @	1.10
Kingston, ground	0.95	

STONE.

Cargo rates at New York.

Amherst freestone, No. 1 per cub. ft.	0.90 @	95
" " No. 2 "	0.75 @	0.80
" " light drab "	0.80 @	0.95
Berlin " in rough "	0.75 @	1.00
Berea " "	0.75 @	1.00
Brownstone, Portland, Ct. "	1.00 @	1.30
" Belleville, N. J. "	0.75 @	1.25
Granite, rough	0.60 @	1.25
Common building stone per load	2.00 @	3.00
Base stone, from 2¾ to 6 ft. lengths, per lin. ft.	0.40 @	3.00

SLATE.

Purple roofing per square	6.00 @	7.00
Green "	6.00 @	7.00
Red "	15.00	
Black Penna. (at New York) "	4.50 @	5.00

LUMBER.

PINE, Common box per M.	18.00 @	20.00
" Good		
Tally plank, 1¼ in each.	.44 @	.50
Tally boards, dressed "	.28 @	.30
SPRUCE, Boards dressed "	.25 @	.28
Plank, 1¼ in "	.28 @	.30
" 2 in. "	.38 @	.40
" 2 in. dressed "	.43 @	.45
Timber per M.	20.00 @	22.00
HEMLOCK, Boards each.	.18 @	.20
Joist, 2¾ × 4 to 4 × 6 in	.17 @	.44
OAK per M.	55.00 @	65.00
CYPRESS 1, 1¼, 2 and 2½ in "	35.00 @	40.00
YELLOW PINE, Girders "	26.00 @	35.00
" Dressed flooring "	30.00 @	40.00
SHINGLES, Extra shaved pine, 18in. "		
" " sawed 18 in. "	4.50 @	5.00
LATH, Cargo rate "	2.50 @	2.60

PAINT.

Lead, white, American dry per lb	.04¾ @	.05
" " in oil pure "	.05¼ @	.05¾
English, B. B. in oil	.08¾ @	.08¾
Red, American "	.05¾ @	.05¾
Litharge "	.05 @	.05¼
Venetian red, American "	.01 @	.01¼
Indian red "	.05 @	.10
Vermillion, American lead "	.11 @	.11¾
Paris green "	.15 @	.19
Umber, Amer. raw and powdered per lb.	.01¼ @	.01½
Drop black, Amer.	.08 @	.12
" "	.09 @	.11¾
Chrome green	.05 @	.15
Oxide zinc, American	.03¾ @	.04
" French	.06¼ @	.06¾

Toledo, Kokoma & St. Louis R. R.—Articles of incorporation of the Toledo, Kokoma and St. Louis Railroad Company were filed on April 7, with the Secretary of State. The capital stock is placed at $5,000000, divided in 5,000 shares. The proposed road is to run from a point in Adams County, on the Eastern line of the State, about a distance of 170 miles to the Western boundary of the State in Vermilion County, and it is practically the line projected by the Toledo, Cincinnati and St. Louis Company.